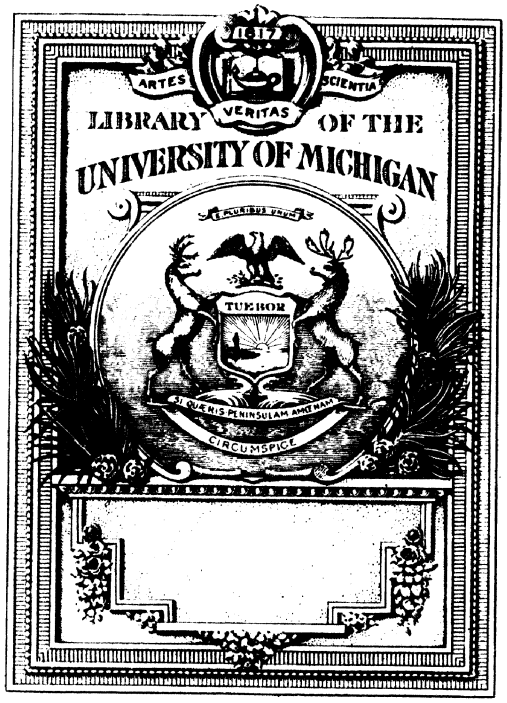
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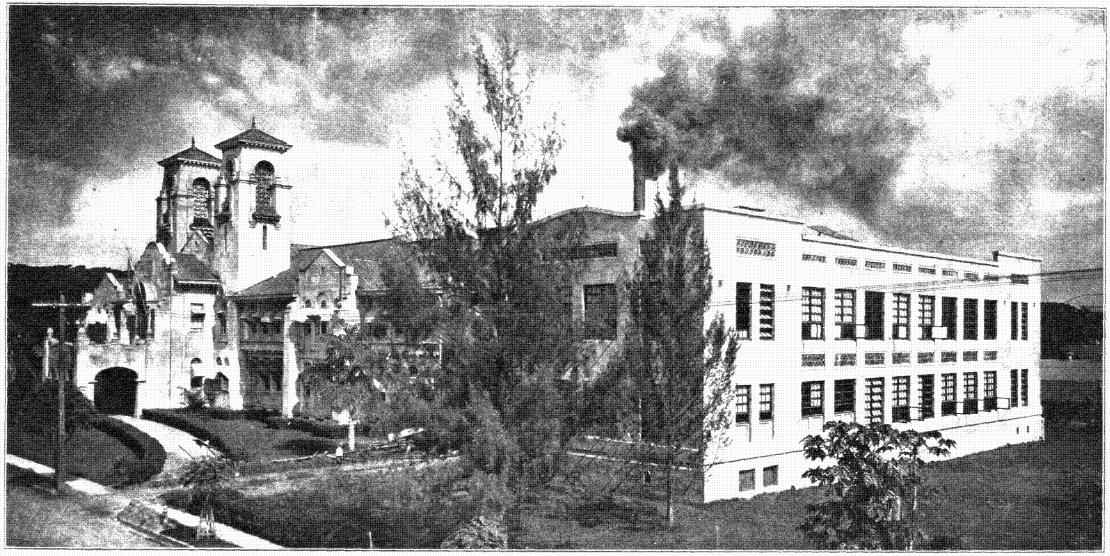


MAIN BUILDING, BUREAU OF SCIENCE.

TWELFTH ANNUAL REPORT OF THE BUREAU OF SCIENCE

PHILIPPINE ISLANDS

TO THE HONORABLE
THE SECRETARY OF THE INTERIOR

BY

ALVIN J. COX
ACTING DIRECTOR OF THE BUREAU OF SCIENCE

FOR THE YEAR ENDING
JUNE 30, 1913

MANILA
BUREAU OF PRINTING
1913

ILLUSTRATIONS

TWELFTH ANNUAL REPORT OF THE BUREAU OF SCIENCE

THE GOVERNMENT OF THE PHILIPPINE ISLANDS,
DEPARTMENT OF THE INTERIOR,
BUREAU OF SCIENCE,
Manila, July 15, 1913.

SIR: I have the honor to present a résumé of the researches of the Bureau of Science and of the work performed during the fiscal year ending June 30, 1913, together with a few recommendations regarding improvements which seem to me to be necessary.

The Bureau of Science was established as the Bureau of Government Laboratories on July 1, 1901, by Act No. 156 of the Philippine Commission, although actual chemical and biological work was first begun on September 25 of the same year when it was started with 6 employees in a rented house on Calle Iris, Manila. The photographic collection, which has developed rapidly and now includes some 15,000 negatives, and other photographic work were begun with the employment of an official photographer on November 16, 1901. Entomological investigations began on December 9, 1902, and with them the foundation of the present entomological collection of specimens. On January 1, 1903, the serum laboratory and the grounds at San Lazaro were transferred to the Bureau from the Board of Health. The section of botany which had been organized in the Bureau of Agriculture and the nucleus of the herbarium were added on July 1, 1903. On November 1, 1905, the Bureau of Mines ceased to exist and became an integral part of the Bureau of Science, and on November 1, 1906, the Ethnological Survey, formerly the Bureau of Non-Christian Tribes, which before that time had been incorporated with the Bureau of Education, was transferred to the Bureau of Science, and, as the division of ethnology, has undertaken the preliminary organization of the Philippine museum and has secured sufficient material to fill three-quarters of the space in the building assigned to it on Calle Juan Luna, one-quarter being reserved for the exhibit of the Bureau of Forestry. The collector of natural history specimens

of the Ethnological Survey was transferred directly to the Bureau of Science (then Bureau of Government Laboratories) on November 16, 1904.

The present laboratory building of the Bureau of Science, which was added to in 1911, was first occupied early in the year 1905, and at that time the work was enlarged by the appointment of an engineering force and by the operation of steam and electric machinery. From this small beginning has grown the present power plant which supplies electric current, steam, gas, etc. to the Bureau of Science, the Philippine General Hospital, and the College of Medicine and Surgery.

The purchase of books for the library began soon after the organization of the Bureau, and this adjunct of the scientific work grew rapidly, necessitating the gradual enlargement of the force and the organization of the library staff. The original plan contemplated an expenditure of ₱90,000 spread over a period of six years for sets of general periodicals and other books on chemistry, geology, zoölogy, bacteriology, pathology, physiology, and general sciences. Books purchased with this fund together with the thousands of pesos' worth of publications which were received gratis formed the nucleus of the scientific library of the entire Government. The valuable material received by gift and the continuations of sets purchased from current appropriations have been bound. These, together with the books and serial literature of the clinical principles such as surgery, skin diseases, and ophthalmology, which have been provided by the University of the Philippines, have been placed in the library.

Work made important by the needs of the Islands was from time to time added to the existing divisions. A cement-testing laboratory—including the testing of road materials and of concrete, sand, and gravel used in structural operations—and a laboratory for the examination of foods and drugs were developed within the division of chemistry. The serum laboratory, which at first had undertaken only the preparation of vaccine virus and a small quantity of antirinderpest serum, increased its scope so as to cover all sera prophylactics used by the Civil Government. The biological laboratory, which had always been connected closely with the Civil Hospital and had done the general scientific work for the Board of Health, undertook the diagnostic determinations for Bilibid Prison, for San Lazaro Hospital for contagious diseases, and, at a later date, a fair share of the teaching and hospital work belonging to the Medical

School. Investigations in the provinces, bringing with them a more extended study of helminthologic infections, also eventually became necessary in order to give a clear understanding of the general condition of the people. Members of the staff are also in periodic demand by the Bureau of Health in conjunction with the collecting of lepers for the Culion Colony. In 1910 the Philippine Assembly established a Bureau of Science sugar-testing laboratory at Iloilo. On November 9, 1910, funds were transferred to the Bureau of Science by the Governor-General for the building of an aquarium in the bastion immediately in front of Real Gate of the city wall. On June 10, 1913, the aquaria and circulating system had been placed in operating condition by the Bureau of Public Works and were turned over to this Bureau.

There was one transfer from the Bureau of Science, namely, that of the serum herd to the Bureau of Agriculture on January 1, 1907.

The Bureau of Science now has not only a local but an international reputation built up on the basis of the quality and volume of the scientific work which we have produced. In the course of the addresses given by those called upon to express His Imperial Majesty's, the German Emperor's, views, at the foundation of the Kaiser Wilhelm Institut for the prosecution of original research, attention was especially directed to the existence of a number of such institutions in America, and it was very gratifying to us to learn that the Philippine Bureau of Science was referred to as a great institution for investigation established by the Government.

The Bureau of Science performs a large amount of routine scientific work for many branches of the Government and for private parties. They are all benefited thereby, and the greater proportion of the results obtained have a permanent commercial value. In the tenth annual report of this Bureau, page 29, attention was called to the fact that in a single day the division of general, inorganic, and physical chemistry had carried on illumination tests of oil; heat insulation experiments; analyses of rocks, limestones and cements, water, soils, fertilizers, coals, and alloys; calorimetric determinations of fuels; standardizations of instruments of precision, of measures, and of solutions; as well as physical tests of clays, cements, aggregates, road materials, textiles—such as puttees, khaki cloth, raincoats, and blankets—and of reënforcing iron and of rope. From this, which was done in one division, one can gain an idea

of the variety of work carried on in a single day in the entire Bureau with its dozen divisions and sections. The analyses or examinations of samples of a given kind which are performed by the laboratory cannot often be segregated because with few exceptions they must be done promptly without waiting for others to accumulate.

Routine work does not prevent the Bureau from fulfilling its lawful function of conducting independent scientific research and working out the problems of economic importance, provided it be of a legitimate character. By a small nominal charge such as we make in most cases, we are able to exclude unimportant samples submitted out of curiosity and only of momentary interest; without such a charge we would be obliged to devote our entire time to routine work at the sacrifice of all our research work. The schedule of prices on the average does not cover more than the actual cost of routine analyses or examinations, on account of the extreme variety of the work. Certain types of analyses are made gratis exclusively for other branches of the Government, and in these cases it has been necessary only to approximate the cost for statistical purposes so the charges in the schedule may be more or less than the actual cost of the routine analyses or examinations. The charges for unusual and miscellaneous work are too low. The large variety of work makes economy of time difficult; the lack of room makes it imperative to disassemble apparatus as soon as work is completed instead of keeping it set up for similar work, as the space is needed for new work, and the irregularity with which requests are received interferes with the intertwining of suitable problems for research and investigations. The irregularity is partially overcome by enlisting the routine employees as secondary workers on investigations. The cost of performing routine work of a given class varies from time to time, depending upon conditions. In the United States a laboratory often secures a large amount of one class of work and can invariably employ cheap assistance and carry it on empirically. For instance, there are laboratories in the States where they do nothing but analyses of boiler water. In spite of their cheap labor, in almost every case their charges are higher than ours. Where the volume of any given class of work performed by the chemists, bacteriologists, assayers, or other employees is large, we are able greatly to reduce the unit cost and especially are we able to do so when we train and use the services of intelligent apprentices. At the present time we have an apprentice mechanical soil analyst, an apprentice milk analyst, and apprentice cement testers. Each of these is able

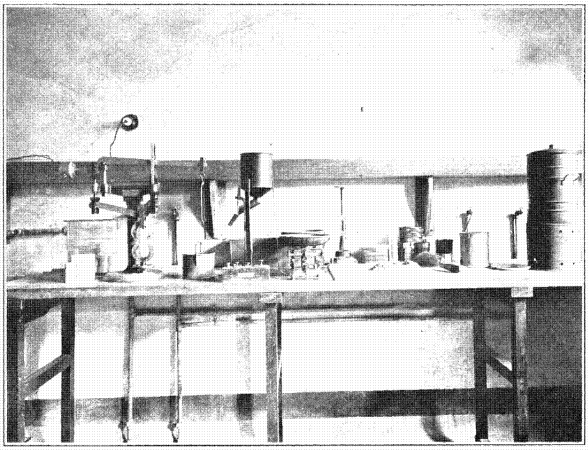


Fig. 1. Bureau of Science cement laboratory in 1906.

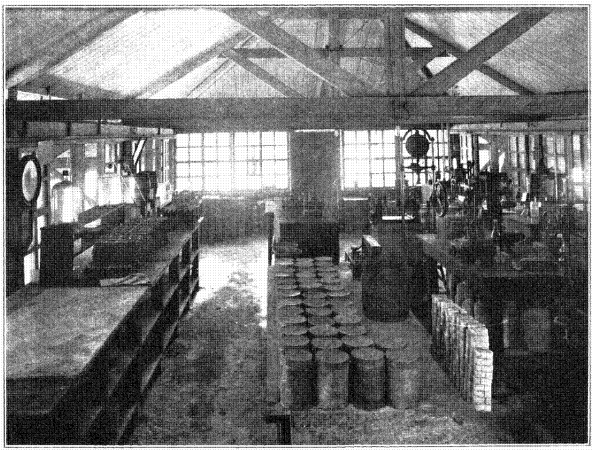


Fig. 2. Bureau of Science cement laboratory in 1913.

PLATE I.

to carry on a large part of the particular class of work independently and thus save the time of an expensive man. The cost of mechanical analyses of soils has been reduced between 50 and 75 per cent. As an illustration of how the price decreases with quantity, I have the honor to refer you to the history of our cement testing. In the fiscal year 1906 we tested fourteen cements; in 1907, one hundred eighty-five; in 1908, one thousand seven hundred nineteen; in 1909, three thousand five hundred ninety-six; in 1910, three thousand two hundred sixty-two; in 1911, three thousand seven hundred twenty-eight; in 1912, seven thousand nine hundred sixty-six; and during 1913 we tested more than nine thousand five hundred samples. In 1906 our authorized charge for cements was ₱30 per sample; in 1907, ₱15 per sample; and at the present time it is ₱0.60 for the same class of test. In the same manner, the cost of analyzing samples of water decreases rapidly when many samples are analyzed at one time. In the decreased cost of work with the increase in volume is to be found the strongest argument for the segregation of the scientific work of the entire Government in one institution like our own. Even when it is all brought together in one class, certain tests are so few in number that the unit cost of performing them becomes very high.

In general, people expect to pay more when work is done by a government laboratory because they have the prestige of the Government back of the results. We have avoided taking advantage of this as shown by the fact that our scheduled charges are consistently very much lower than the charges made by equally reputable commercial and other institutions or laboratories of the United States. Our continued effort is to be of as much assistance as possible, and often we carry work farther than is requested when it is evident that the public can be benefited. For example, sometimes individuals draw conclusions from analyses on the basis of findings in other countries. Often this is erroneous, and we endeavor to settle the problem by careful research.

The results of many of the investigations of the Bureau of Science, although available at present, do not become of most value until they are utilized from an industrial, commercial, or educational standpoint. Research work indicates the latent wealth of the nation, and bears the same relation to the commercial world that blocked-out ore does to a developed mine. The intrinsic value and the potential importance of this work are becoming more and more evident as its practical application is demonstrated and appreciated. It is not always easy to antici-

pate the needs of the country in order to determine which investigations should be carried on first, and certain problems require years for completion, so that much of the work becomes most useful at a later date. It is in the nature of the case that our work must precede the establishment of large industries and consultations with, and advice to, the public and other branches of the Government requiring scientific knowledge of a specialized character. A large amount of the research of this Bureau has been made available in our publications which to date comprise 20,000 printed pages, 2,000 illustrative plates, and nearly 1,000 text figures.

RÉSUMÉ OF THE RESEARCHES OF THE BUREAU OF SCIENCE

To give in a few pages a complete account of the investigations carried on by this Bureau would be impossible. The space which I propose to devote to this would not adequately record the accomplishments of a single division or section. For instance, to describe the work of the biological laboratory of this Bureau would be to write no small part of the history of the development of tropical medicine during the past twelve years. I desire to emphasize, however, that there is extensive information in the Bureau of Science which would effect a large annual saving to the inhabitants of these Islands if it were utilized, as shown in the following abstract of the work of the Bureau.

1. *General.*—Specimens of plants have been imported at considerable expense that might just as well have been secured in the Philippine Islands and in many cases in the city of Manila itself. Some living plants infested with various fungus diseases have been imported, and the introduction of such diseases might have been avoided if the plants had been submitted to this Bureau for examination. Some of the dam sites could have been more advantageously chosen had the geologist been consulted when the work was projected. At least one gold mill which cost several hundred thousand pesos now stands idle in the Philippines because there were no previous tests to show the kind of mill adapted to the ore. Investigation of one operating mill in the Philippines showed that a saving could be made of nearly ₱5 per ton of ore treated or about ₱94,000 per annum. Geologic investigations of artesian water show infeasible projects and prevent unwise expenditures. The specifications for a large Government building required a 1:2:4 concrete mixture. The mixture was found to give poor results. The cement and aggregate were carefully studied by this Bureau, and it was found that a 1:2:5 mixture gave better results and was more satisfactory than the 1:2:4

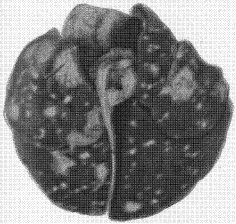


Fig. 1. Lung of guinea pig which died of advanced plague infection, after being exposed to air in which plague bacilli were suspended by means of spraying.

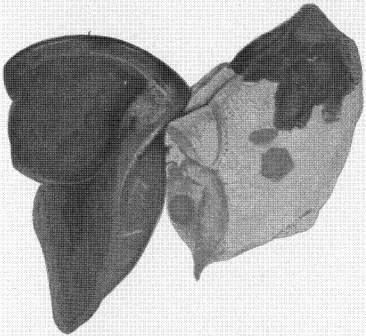


Fig. 2. Lung of monkey which died of pneumonic-plague infection from inhalation, showing progression of lesions; lobular and lobar pneumonia.

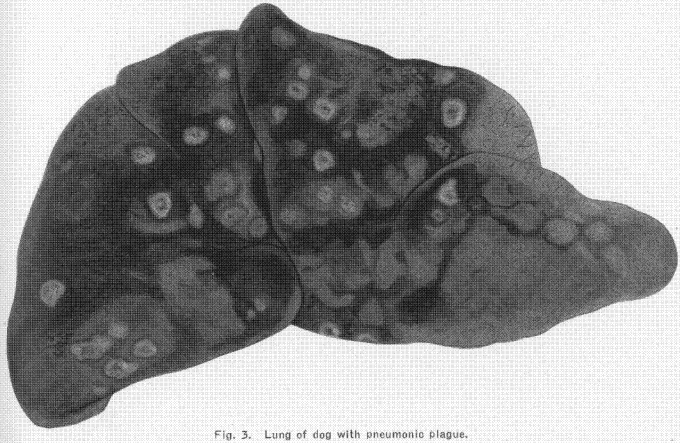


Fig. 3. Lung of dog with pneumonic plague.

PLATE II.

mixture. The contractor was allowed to use the 1: 2: 5 mixture in the construction work. If it had been known by the engineers in charge before bids were submitted that this mixture was as good as the 1: 2: 4, there could have been a large saving. Several thousands of pesos were paid to private laboratories in Europe and America for the purpose of ascertaining the suitability of submitted samples of local raw cement materials for commercial use. In most instances this Bureau in the beginning could have done the work cheaper and more efficiently. The results gave no definite information until the material was submitted to our experts for examination. Our equipment for conducting investigations is much better than that of most commercial laboratories, and our scientists are familar with local conditions which must be considered. Scientific information will assist the manufacturer of coconut products, soaps, beverages, alcohol, sugar, etc. Sugar planters' profits have been greatly augmented in many cases by scientific information regarding the proper time at which to crush their cane; that is, when the cane contains the maximum quantity of juice of maximum purity.

2. *Diseases of man.*—Medical surveys have been conducted in various parts of the Archipelago to determine the kinds of diseases and their prevalence. These diseases have been studied with reference to their etiology, pathology, treatment, immunity, and prevention. Knowledge has been obtained for the treatment and prevention of many of these that is of inestimable value not only to the inhabitants of the Philippines but to mankind in general.

The diseases of man which have been investigated in the biological laboratory include plague, cholera, bacillary dysentery, tuberculosis, leprosy, entamœbic dysentery, balantidiasis, malaria, helminthiasis, yaws, beriberi, meningitis, tropical ulcers, gangosa, varicella, mycetoma, splenomegaly, rabies, hand infection, and pinto. The first eleven of these are reviewed more fully as follows:

3. *Plague.*—Manila has suffered from two outbreaks of bubonic plague during the past nine years, and a representative of this Bureau went as the American delegate to the International Plague Conference in China during the epidemic of pneumonic plague in Manchuria in 1911. Therefore, abundant opportunity and material have been available for the study of both types of this disease. The investigation of pneumonic plague was based on the material brought from Manchuria. The method of the spread of this most contagious form of plague and the probable reason why epidemics of this form occur only in cold countries

have been indicated. The clinical symptoms, bacteriology, pathology, and the susceptibility of animals to pneumonic plague have been studied. Protective inoculations have been found to be less effective against pneumonic than bubonic plague. The first outbreak of bubonic plague in Manila after the American occupation was eradicated by the combined action of the Bureau of Science and the Bureau of Health, and the last case appeared in 1906. The first case of the present desultory outbreak occurred on June 19, 1912. The control of the present outbreak has been based upon the bacteriological diagnosis of the suspected cases of human plague and the examination of many thousands of rats. Investigations have been made as described on page 46.

4. *Cholera.*—Since July, 1911, not a single case of cholera has been reported in this Archipelago. This Bureau has taken an important part in its elimination by the pathological and bacteriological diagnosis of the disease, by the preparation of immune serum for diagnosis, and by prophylactic inoculations against it; the Bureau has also made many investigations on the cholera organism and immunization against, and treatment of, the disease. A new prophylactic, consisting of the immunizing substances extracted from the cholera vibrios, was devised and employed in immunizing in the last epidemic of cholera. Physiological and biochemical studies in this laboratory have determined the efficiency of different concentrations of saline solutions employed as extravenous injections in treatment of collapse in cholera, have found evidence of an acid intoxication in this disease, and on the basis of this evidence have proved that early administration of alkalies will practically eliminate death from uræmia. A new and quicker method of identifying the vibrio of Asiatic cholera has been devised (see page 47).

5. *Bacillary dysentery.*—Dysentery of bacterial origin, while not strictly a tropical disease, is one of increasing importance in warm countries. One type of the organism causing this disease was discovered in the Philippines, and sporadic cases, outbreaks, and epidemics are more frequently recognized. Several varieties of the dysentery bacillus are known. Investigations have shown that all of the different types occur in the Philippine Islands, and on page 47 recent isolation experiments by the single-cell method are described. Bacillary dysentery has been found to occur in monkeys of the Philippine Islands, a fact which might, under certain conditions, play a part in its spread. Infantile diarrhœas and dysentery are an important

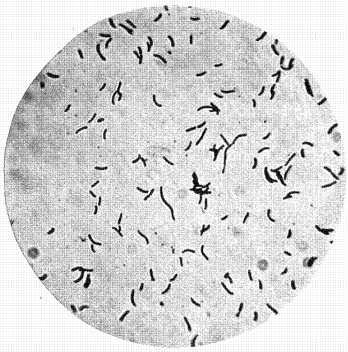


Fig. 1. Vibrio of Asiatic cholera.

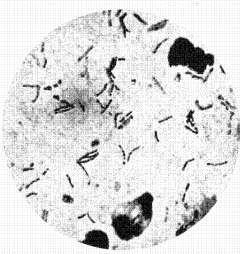


Fig. 2. Bacillus tuberculosis.

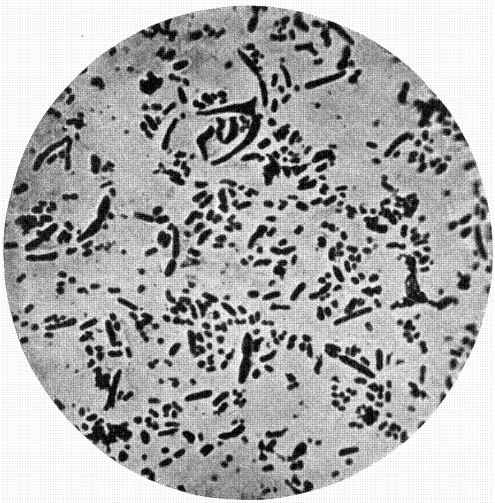


Fig. 3. An atypical strain of Bacillus dysenteriæ.

PLATE III.

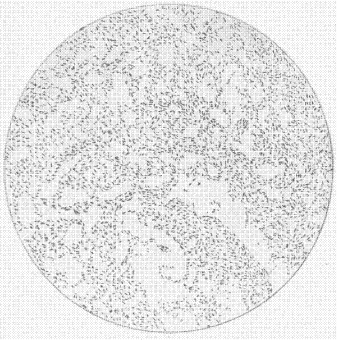


Fig. 1. Pure culture of leprosy F from glycerine agar.

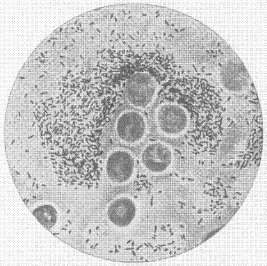


Fig. 2. Amœba with cholera vibrio and leprosy bacillus G. Second transplant from primary culture.

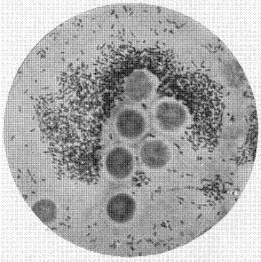


Fig. 4. Culture G. Leprosy bacilli with amœbæ and cholera vibrios. Stained with carbol-fuchsin and decolorized with Gabbet's stain.

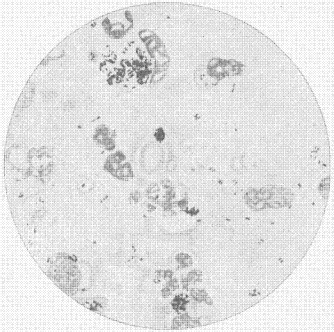


Fig. 3. Smear from early lesion in guinea pig following a subcutaneous injection of a pure culture of leprosy bacillus F.

PLATE IV.

factor in the infant mortality of all tropical countries. In a study of an epidemic of infantile dysentery in 1908, an undescribed bacillus of the *coli* group, not *Bacillus dysenteriæ,* was found to be the causative organism.

6. *Tuberculosis.*—This disease constitutes one of the most important medical problems among the Filipinos. The incidence of infection has been more accurately determined by several medical surveys conducted by this Bureau than could be done by the statistics of hospital clinics. The pathology of various kinds of tuberculosis, notably of rare types such as adrenal tuberculosis, has been studied. Certain specific treatments of tuberculosis have been tested, and experiments in the attempt to immunize against tuberculosis with a virulent strains of *Bacillus tuberculosis* have resulted negatively. Recent studies of tubercular infections are described on page 47.

7. *Leprosy.*—The first cultivation of an organism from leprous tissue by this Bureau, even if it should prove not to be the specific organism of leprosy, has been the starting point of the extensive cultivation and experimental studies of leprosy now in progress all over the world. An investigation is now in progress with special reference to classifying those organisms cultivated from leprous tissue by different authors and to the determination of their etiologic relationship to leprosy. Studies on the cutaneous reaction in leprosy, as a method of diagnosis of the disease, as practiced in tuberculosis, and of the treatment of leprosy with a vaccine prepared from an organism cultivated from leprosy, and with certain chemicals, have been made.

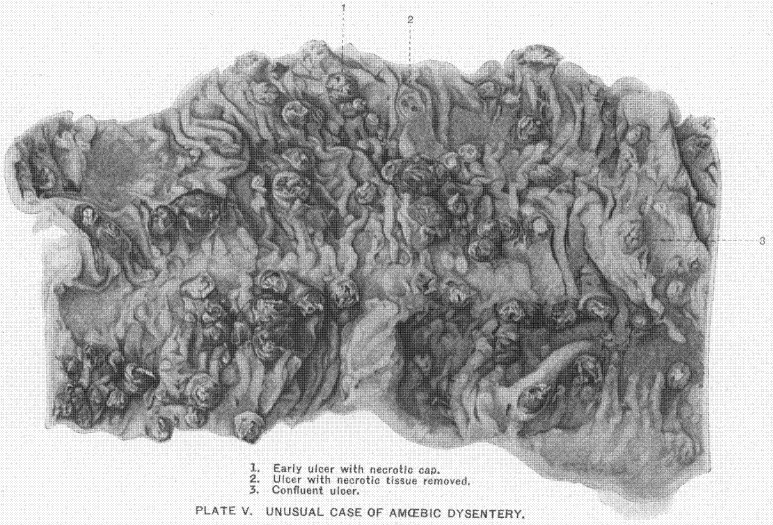
8. *Entamœbic dysentery* is a disease of universal distribution in the tropics and subtropics, and one which causes much sickness and death of white men. It was very prevalent in the Philippines in the early years of the American occupation, and, although sanitation has decreased its prevalence, it is still by no means uncommon. Its importance in the Philippines has led to much investigation of its etiology, diagnosis, pathology, and treatment. Recent morphological and experimental investigations carried on in this Bureau have determined once for all the specific entamœba concerned in the production of this disease, and have supplied information for the accurate laboratory diagnosis and for the scientific control of entamœbic dysentery. It has been determined that the entamœba causing dysentery lives only in the intestine of man, that every case of entamœbic dysentery is contracted from some other case of dysentery, and that it cannot be contracted from water or uncooked vegetables

unless they be contaminated with the fæces of a case of entamœbic dysentery. The results which have been obtained will appear in The Philippine Journal of Science (see page 48).

9. *Balantidiasis.*—The first case reported in the Philippine Islands of infection with the ciliated protozoan, *Balantidium coli,* was in 1900. The early reports of this Bureau indicated that balantidiasis, while sometimes giving rise to a fatal dysentery, was a disease of rare occurrence. However, recent investigations have shown that infections of man with this parasite are relatively frequent and of wide distribution in these Islands and consequently deserving of further study (see page 48).

10. *Malaria.*—This is probably the most widespread of all tropical diseases. Investigations conducted in this Bureau in 1910 showed that about 12,000 deaths due to it are reported each year in the Philippine Islands. Incidence of infection in certain parts of the Philippine Islands has been determined by medical surveys conducted by the Bureau of Science. At Taytay, Luzon, the incidence as determined by the examination of 1,131 persons was only 1.5 per cent. It was found to be prevalent in the pernicious type in Itbayat Island of the Batanes group, but no statistics were secured. At the San José estate on Mindoro the incidence as determined by the examination of over a thousand blood smears from different persons for malarial parasites was about 30 per cent (see page 48). Experiments have been conducted on the treatment of malaria with arsenophenylglycin and on the transmission of malaria by the anopheline mosquito, *Myzomyia ludlowii.*

11. *Helminthiasis.*—Infections with worm parasites are very prevalent in the Philippines as they are in all tropical countries. Numerous extended statistical studies have been made of the prevalence and distribution of the intestinal parasitic worms in different parts of the Philippine Islands, including Manila; Taytay, Rizal; Las Piñas, Rizal; Tuguegarao, Cagayan; Santa Isabel, Isabela; Baguio, Benguet; and San Antonio and Malauno, Isabela. In all, 19,302 persons have been examined, of whom 16,535, or 85.66 per cent, were found with single or multiple infections with verminous parasites. Cases of infection with the rarer worm parasites and at least one new species have been discovered. Investigations have been made on trichocephaliasis and on the etiology, pathology, symptomatology, and treatment of paragonimiasis in the Philippines. The efficient prophylaxis against certain worm parasites depends upon a knowledge of their complex life histories, especially of that part of their development which takes place outside of man. With this



1. Early ulcer with necrotic cap.
2. Ulcer with necrotic tissue removed.
3. Confluent ulcer.

PLATE V. UNUSUAL CASE OF AMŒBIC DYSENTERY.

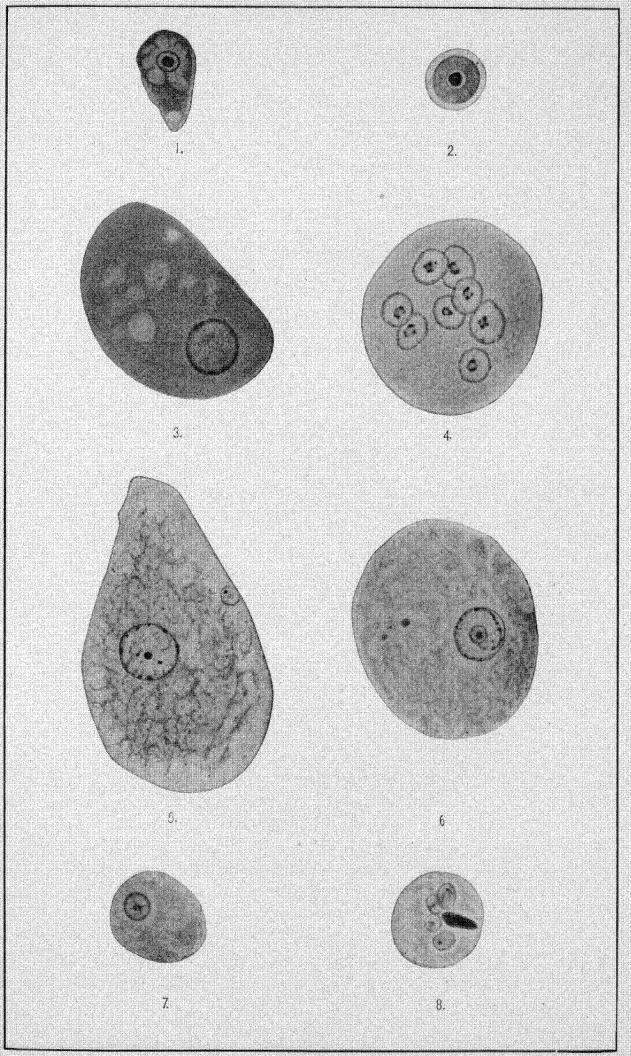


PLATE VI. TYPICAL EXAMPLES OF AMŒBA AND ENTAMŒBA.

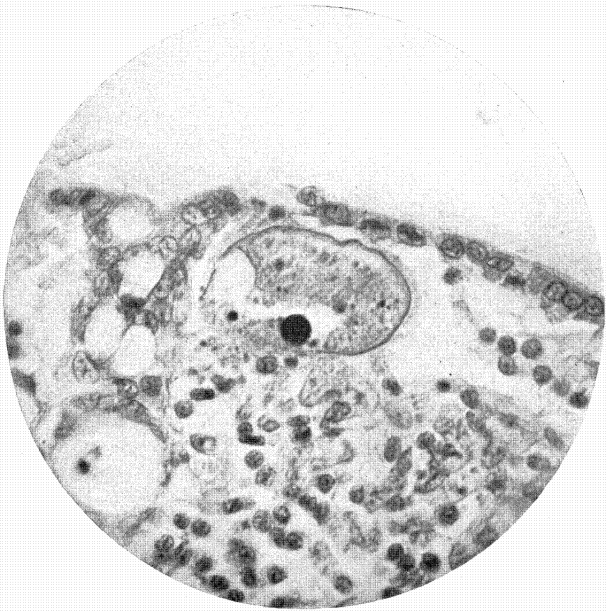


PLATE VII. SECTION OF LARGE INTESTINE OF MONKEY, SHOWING A SINGLE BALANTIDIUM COLI SUIS UNDER THE HEALTHY INTESTINAL EPITHELIUM.

PLATE VIII. SECTION OF A MESENTERIC LYMPH GLAND OF MONKEY, SHOWING SEVERAL BALANTIDIUM COLI HOMINIS IN THE EDGE OF THE GLANDULAR TISSUE.

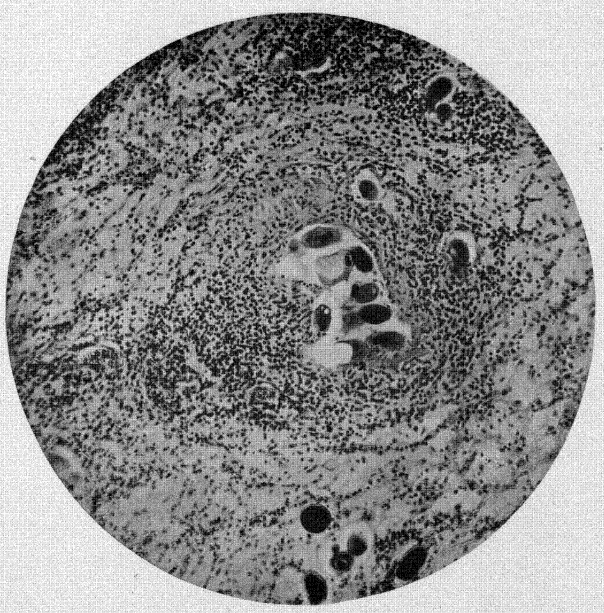


PLATE IX. SECTION OF THE LARGE INTESTINE OF A MAN DEAD FROM BALANTIDIAL DYSENTERY.

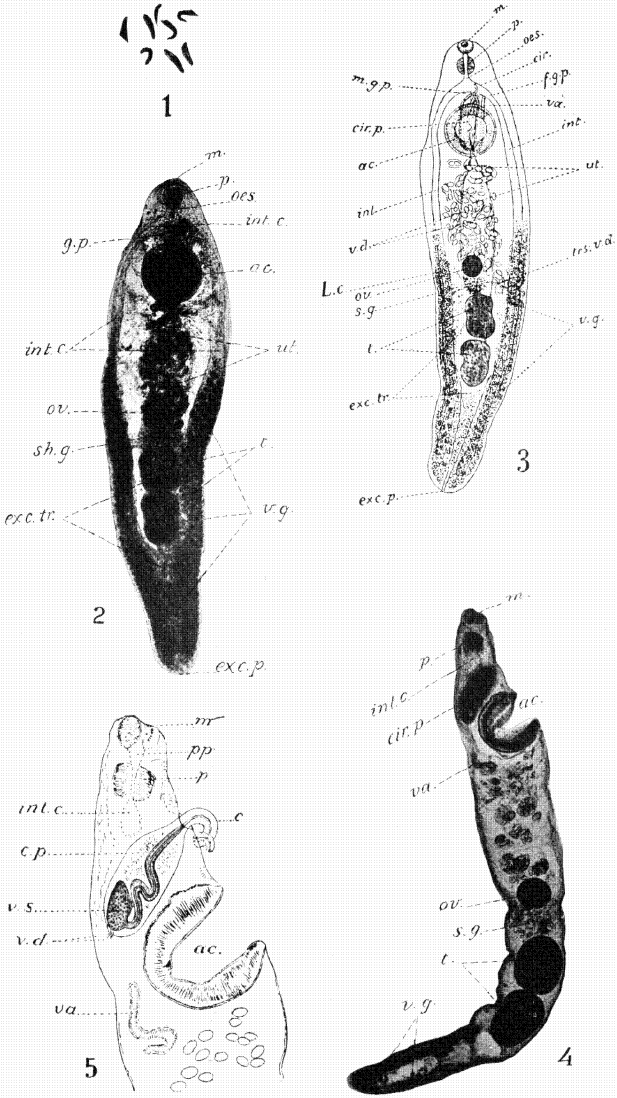


PLATE X. AN INTESTINAL TREMATODE OF MAN.

knowledge in view, studies have been made of the development and life history of *Paragonimus* and *Œsophagostomum* (see page 49).

12. *Yaws.*—The occurrence and distribution of yaws and the histology of the lesions of this disease have been investigated, and three years ago a specific cure for yaws was discovered. Dr. Paul C. Freer describes this on pages 13 and 14 of the Tenth Annual Report as follows:

> Ehrlich and his pupils had found that dioxy-diamido-arsenobenzol had produced very favorable results in the treatment of fowl spirochætosis and syphilis and, therefore, the idea suggested itself to try the remedy in yaws, because of the morphologic and biologic relationship which exists between the spirochætæ giving rise to yaws and syphilis respectively. It was found that dioxy-diamido-arsenobenzol is an ideal specific for yaws. Three or four days after the injection of the drug, the granulomatous lesions begin to improve and in the course of from ten to twenty days they usually have disappeared entirely, leaving a perfectly smooth, pigmented skin where the lesions previously existed. The absorption of tumor masses measuring several centimeters in diameter and about a centimeter in thickness in so short a time, and under the influence of no local treatment, is very striking and surprising. Indeed, in the severe cases the disappearance of the lesions and the cures produced can most aptly be spoken of as marvelous. Even large granulomatous masses or deep ulcerations heal within from two to four weeks. No more striking example in medicine is known than that of the specific action of dioxy-diamido-arsenobenzol on the lesions of yaws. It would appear that this chemical individual is as important a specific for yaws as quinine is for malaria. Therefore, a fourth specific in medicine has been discovered.

13. *Beriberi.*—This oriental disease is prevalent in the Philippines, and the deaths from beriberi among residents of Manila during the years 1910, 1911, and 1912 were more than the deaths from tuberculosis of the lungs and far more than the combined deaths from cholera, smallpox, bubonic plague, and typhoid fever during the same period. Investigations first undertaken by this Bureau have demonstrated that the excessive infant mortality in these Islands is chiefly due to infantile beriberi. Extensive experiments on man made by this Bureau with different diets—including red, or polished, and white, or decorticated, rice—have proved that beriberi is a disease of nutrition and not an infection, and have demonstrated that white or decorticated rice, which is the staple article of diet of the Filipino, is the chief cause of the prevalence of the disease in the Philippines. It has been demonstrated that it can be prevented by the use of unpolished rice instead of polished or decorticated rice, and by this means the disease has been eradicated from all Philippine Government institutions.

14. *Animal diseases.*—The animal diseases investigated by the biological laboratory of this Bureau include hæmorrhagic septicæmia, glanders, bronchopneumonia, surra, piroplasmosis, and rinderpest. The preparation of antirinderpest serum and investigations of rinderpest virus and serums and tests of the efficiency of treatment with serum by the simultaneous method with virus and serum have been carried on. The treatment of surra with Ehrlich's new trypanocide, arsenophenolglycin, was tested in a considerable series of experiments in the laboratory and in the field by members of the staff, with better results than had before been secured with other drugs or chemicals.

15. *Pathology and histology.*—Besides the study of the pathology of the tropical diseases, much special pathological investigation has been performed upon abnormal and morbid conditions found in the course of many hundreds of autopsies. A large series of histological examinations has been made upon material from the surgical clinic of the Philippine General Hospital.

16. *Immunity and tropical sanitation.*—Substantial contributions have been made to the theory and practice of immunity. The immune sera and bacterial products used in the therapy of, and immunization against, infectious diseases prepared in the serum laboratory of this Bureau and used for vaccination against smallpox; antirabic treatment; bacterial inoculation against cholera, plague, and typhoid; serum treatment of diphtheria and tetanus; etc. have played no inconsiderable part in the sanitation of the Philippines. Furthermore, numerous researches have been contributed to our knowledge of the preparation, application, and efficiency of serum and vaccine immunity and treatment of diseases.

Back of all executive work and the application of scientific measures for sanitation stands the laboratory, which must make the diagnosis, develop the principles of scientific sanitary measures by experiment, and test the efficiency of the results. The results of this work have assisted in reducing the death rate of the tropical city of Manila below that of many cities in Europe and the United States. The hundreds of thousands of laboratory examinations and diagnoses of infectious diseases, the preparation of protective and curative sera and vaccines, and the bacteriological examination of water supplies have contributed immeasurably to this sanitary improvement.

17. *Mosquitoes.*—Experiments at Olongapo, the United States naval station, demonstrated the transmission of malaria by the most prevalent species of anopheline mosquito of the Philippine

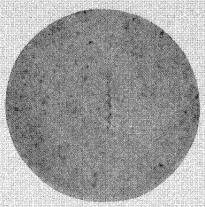


Fig. 1.

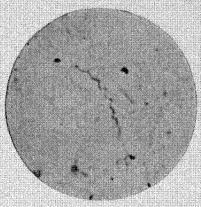


Fig. 2.

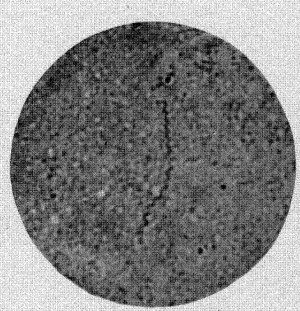


Fig. 3.

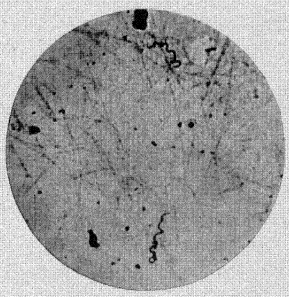


Fig. 4.

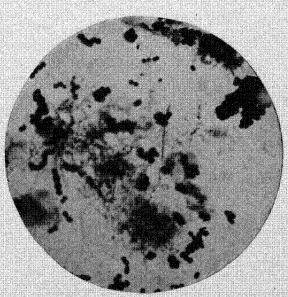


Fig. 5.

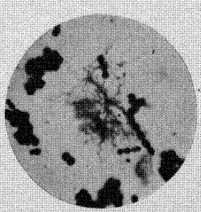


Fig. 6.

PLATE XI. TREPONEMA PERTENUIS CASTELLANI OF YAWS.

Fig. 1. Case I, before treatment.

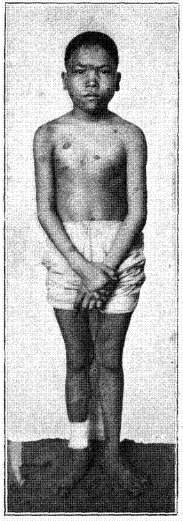


Fig. 2. Same after treatment.

Fig. 3. Case II, before treatment.

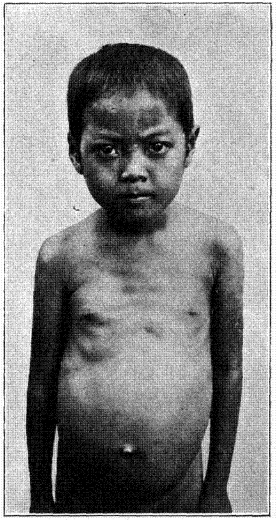


Fig. 4. Same after treatment.

PLATE XII. THE SPECIFIC CURE OF YAWS WITH DIOXY-DIAMIDO-ARSENOBENZOL.

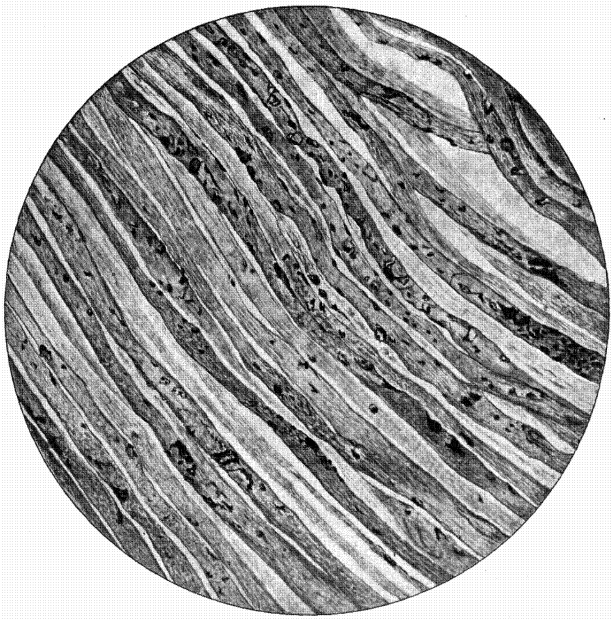


PLATE XIII. LONGITUDINAL SECTION OF VAGUS NERVE.

Fig. 1.

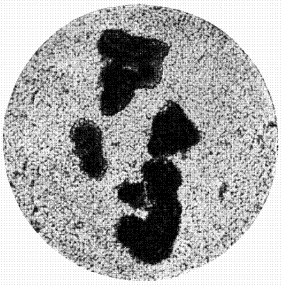


Fig. 3.

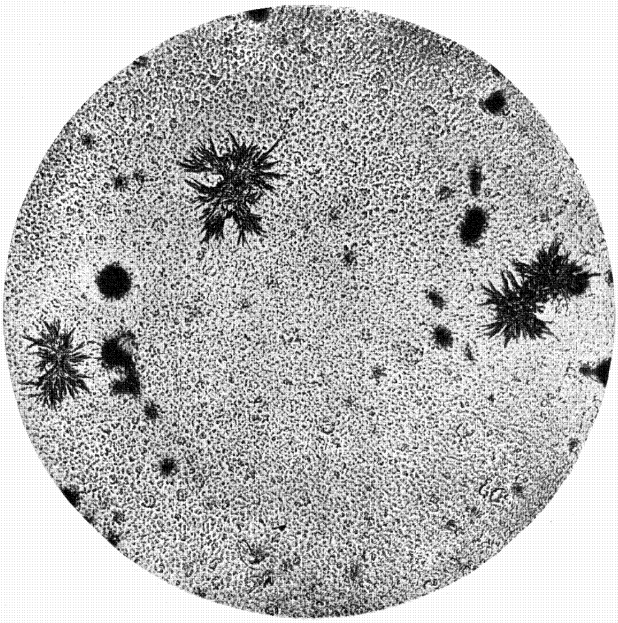


Fig. 2.

PLATE XIV. ETIOLOGY OF MYCETOMA.

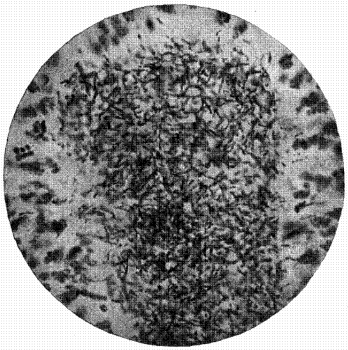


Fig. 1.

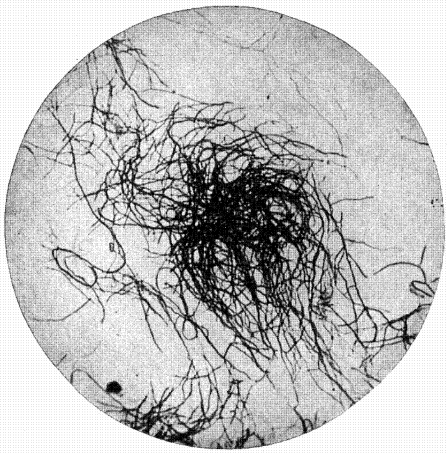


Fig. 2.

PLATE XV. STREPTOTHRICOSIS WITH SPECIAL REFERENCE TO THE ETIOLOGY AND CLASSIFICATION OF MYCETOMA.

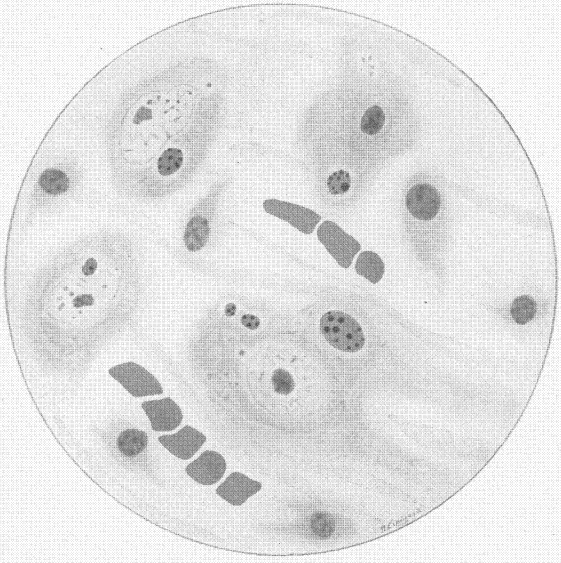


PLATE XVI. HYDROPHOBIA IN THE PHILIPPINES.

Fig. 1.

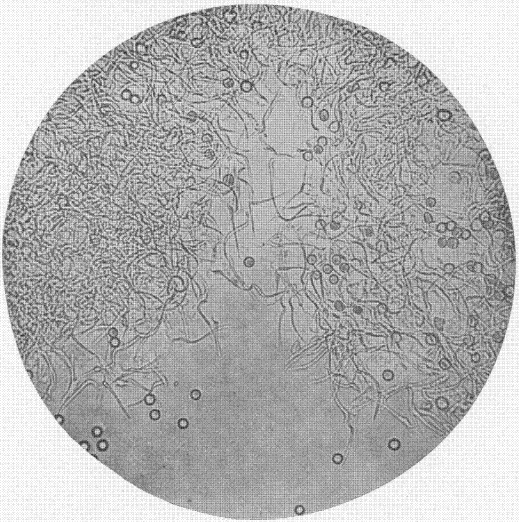


Fig. 2.

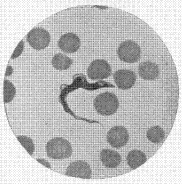


Fig. 3.

Fig. 4.

Fig. 5.

PLATE XVII. STAGES OF A PIROPLASMA AND OF A TRYPANOSOMA OF CATTLE AND THE SCHIZOGONY OF TRYPANOSOMA EVANSI IN THE SPLEEN OF THE VERTEBRATE HOST.

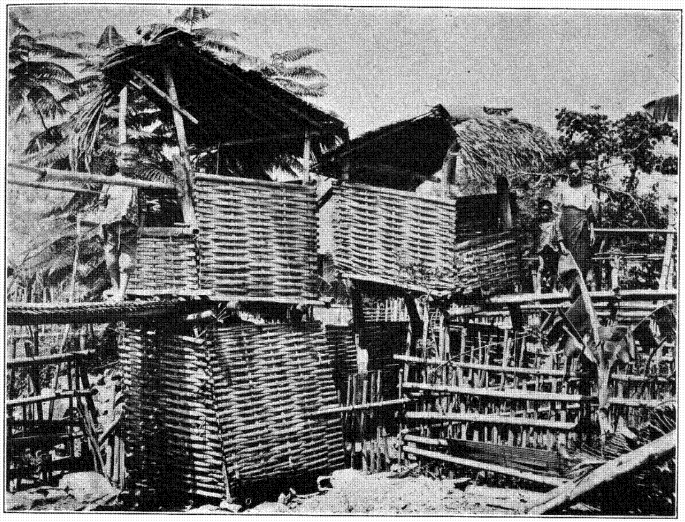


Fig. 1. Typical outhouses.

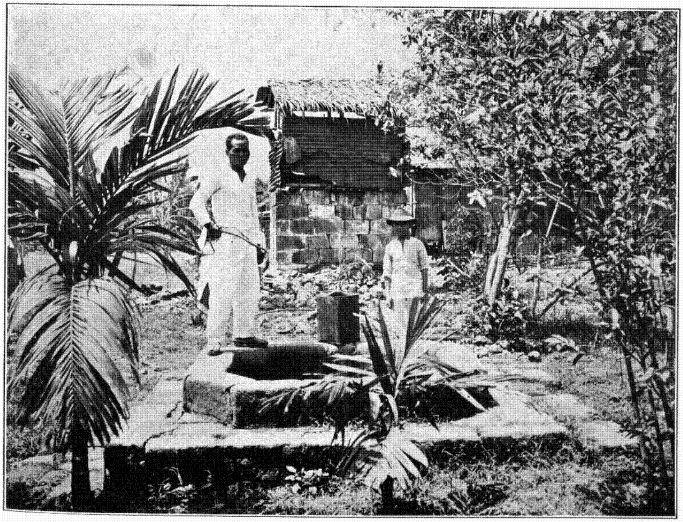


Fig. 2. Outhouse in proximity to well.

PLATE XVIII. MEDICAL SURVEY OF TAYTAY.

Islands, and sanitary measures looking to the eradication of this mosquito have been put into effect, especially in Manila, Iloilo, and Baguio, with results that can certainly never be estimated or even approximated in money.

The eradication of the night mosquito (*Culex fatigans*), known to carry filaria and to be a possible factor in dengue fever, has been practically accomplished in Manila, Iloilo, and Baguio, and Manila is free from this pest at the present time. As soon as recommendations by us as to filling, draining, and building precautions are complied with, Manila will be a mosquito-free town.

18. *Household insects.*—The pests of the household, such as cockroaches, bedbugs, lice, and fleas, while present in all civilized countries, are especially numerous in tropical countries owing to climatic conditions favoring their uninterrupted multiplication. Advice has been given as to the most approved means of attacking these pests.

19. *Flies.*—While a pest to the householder, flies are really more of a community insect in that they usually breed on common dumping grounds of horse manure and garbage and in certain articles in process of manufacture. Successful campaigns under the direction of this Bureau have been waged against this insect in Manila, Iloilo, Baguio, and Aparri.

20. *Animal parasites.*—Our investigations have suggested measures for the protection of cattle, carabaos, horses, dogs, and other domestic animals from the parasites that infest them. The Australian and not the American species of cattle tick is the one commonly found in these Islands. Means of preventing human myiasis frequently have been recommended.

21. *Termites.*—In the Philippines as in all other tropical countries, termites ("white ants") do incalculable damage to commercial timbers of many kinds and to buildings constructed in whole or in part of wood. They perform a wonderful and little-known function in the rapid consumption of fallen timbers in the forest, thus making room for new growth. The only feasible methods of combating these pests are to use timbers impregnated with some repellent, such as crude petroleum and coal-tar products, and to destroy the underground nests in the vicinity. No remedy except the removal of infested material is known for termites once they get into sidings, moldings, ceilings, and the like. Many private as well as public buildings in Manila and in the provinces have been freed from this pest by the methods suggested above.

22. *Locusts.*—The so-called locust fungus was used by this Bureau as early as 1901, as well as *Coccobacillus acridiorum*

d'Herelle during the past few months, in experiments against locusts in various parts of the Philippines, but neither has been effective in exterminating the insects. As early as 1905 recommendations looking to the establishment of the present method of combating this pest were made to the Executive Secretary and the Director of Agriculture, and resulted in the present laws with reference to the matter.

23. *Tobacco pests.*—Tobacco is attacked in the field by the tobacco worm and plant lice, and it has already been demonstrated that hand picking is the only sure and cheap way of combating the former of these pests while the latter may be held in check or practically eradicated by spraying with a weak kerosene emulsion which in no way injures the leaf. Data concerning, and remedial measures which may be applied in various tobacco factories in Manila for combating, the cigarette beetle have been furnished. If these suggestions had been followed during the past three years in the 19 factories in Manila, which have an export trade, there would have been a net saving of over ₱39,000 on the losses which occurred for cigars actually destroyed in the factories alone, not considering the loss of stock outside of the factory due to the same cause or to loss of trade due to the shipment of infested stock.

24. *Cacao insects.*—It has been shown that the most effectual means of controlling cacao insects is that of clean culture in the cacao orchards, together with the use of repellent substances to keep away the borers liable to attack the trunk, and the spraying of fruits and leaves for biting and sucking insects. There is no place in these Islands so far as known where this crop has been given even semiscientific attention, although it is one of the most promising of the many crops.

25. *Rice insects.*—In the field, rice is attacked seriously by four different insects; namely, locusts, the rice army worm, the rice stem borer, and the *tiañgao,* an insect which sucks the milk from the setting grain. It has been shown that these insects have their regular times of development and that their ravages can be lessened by changing the time of planting rice so as to avoid having it in a condition of susceptibility when the insects are at the stage when they attack. Some farmers have profited by this procedure, but as this can only be brought about by the use of irrigation general relief cannot be looked for until irrigation is commonly practiced.

Stored rice is subject to the attacks of weevils, and this can be prevented by properly constructed receptacles. The weevils

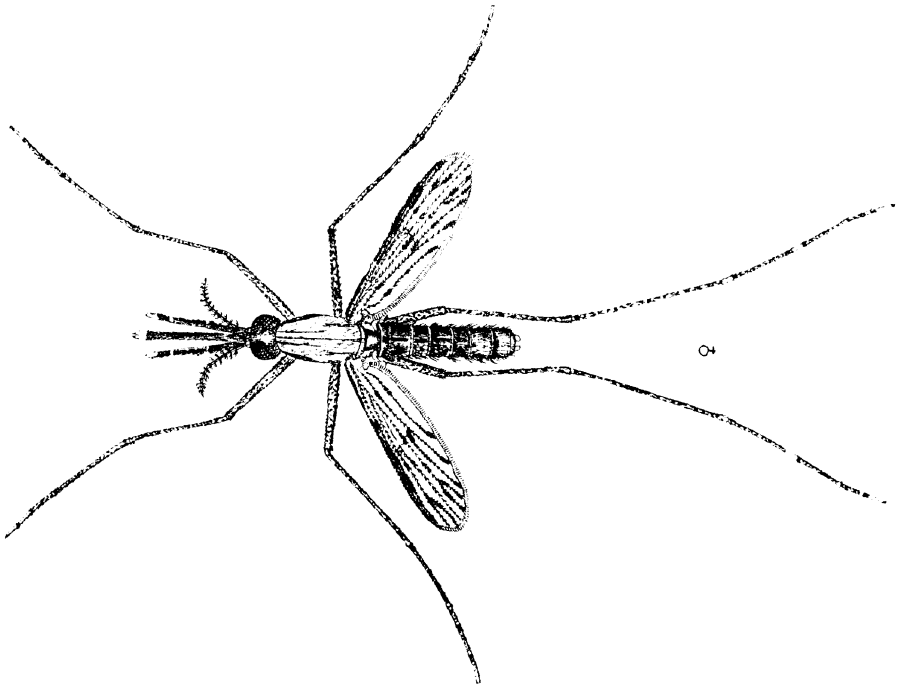


Fig. 1. Adult female of Myzomyia ludlowii Theob. × 8.

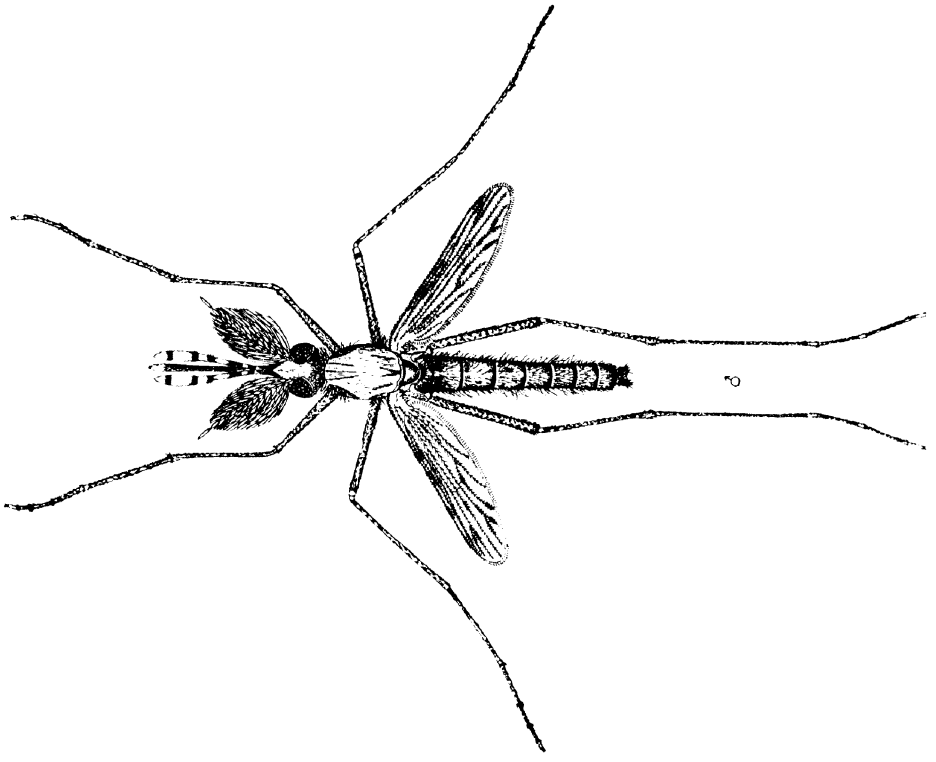


Fig. 2. Adult male, same. × 8.

PLATE XIX. EXPERIMENTS IN MALARIAL TRANSMISSION BY MEANS OF MYZOMYIA LUDLOWII THEOB.

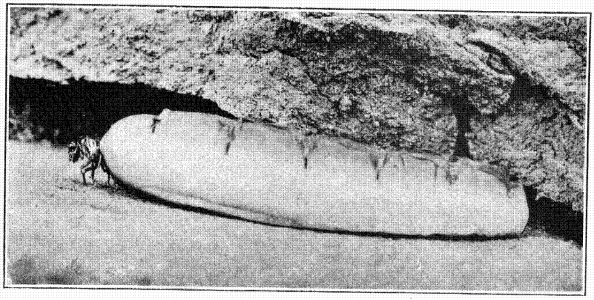


Fig. 1. A queen termite in the queen cell. Natural size.

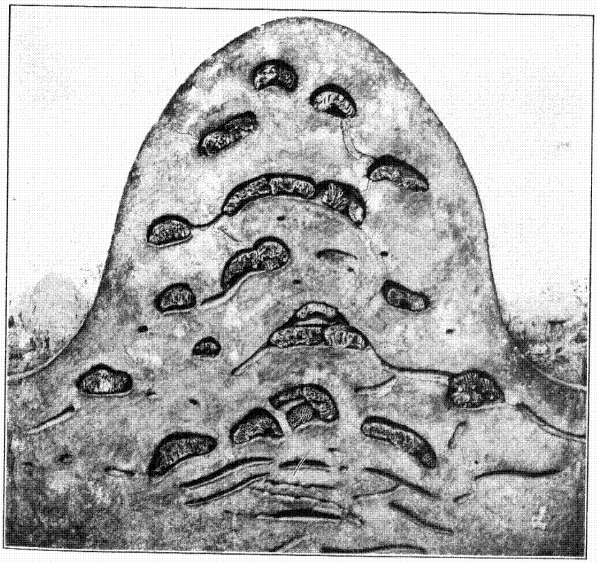


Fig. 2. Model of a cross section of a termite cone.

PLATE XX.

Fig. 1. Cigars showing infestation by cigarette beetles; (*a*) character of injury where a larva gets between two cigars.

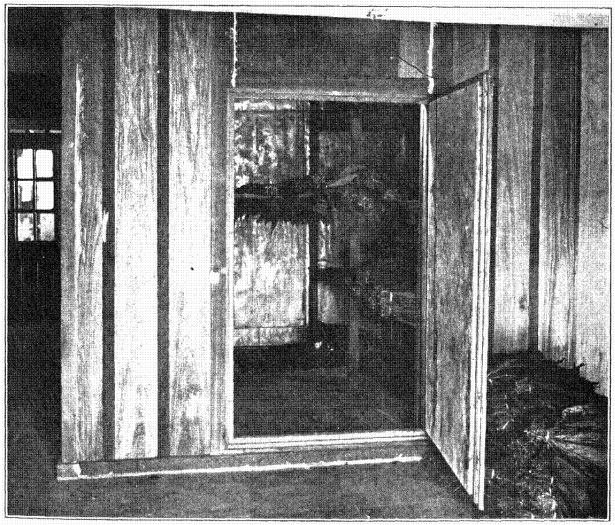


Fig. 2. Fumigating-compartment, showing tobacco wrapper on shelves.

PLATE XXI.

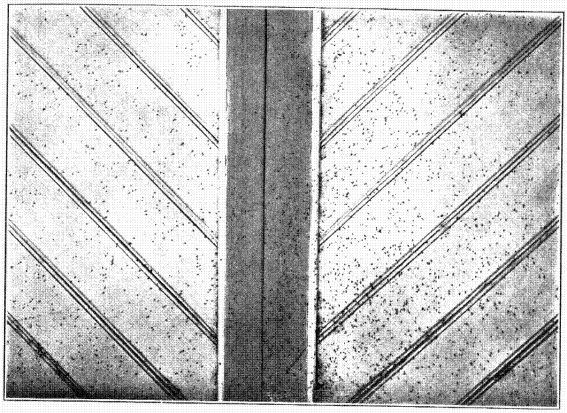


Fig. 1. Freshly painted doors of a bodega, showing adult cigarette beetles.

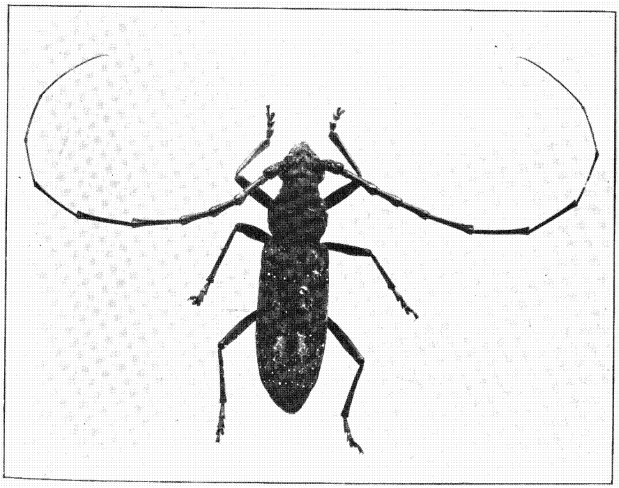


Fig. 2. Cerambycid, adult.

PLATE XXII.

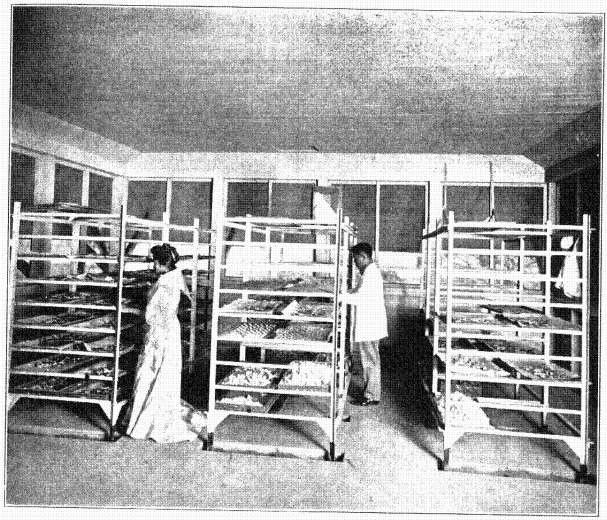


Fig. 1. Interior of a silk house, showing ant-proof racks for the silkworms.

Fig. 2. Silk-reeling exhibition at the Philippine carnival.

PLATE XXIII.

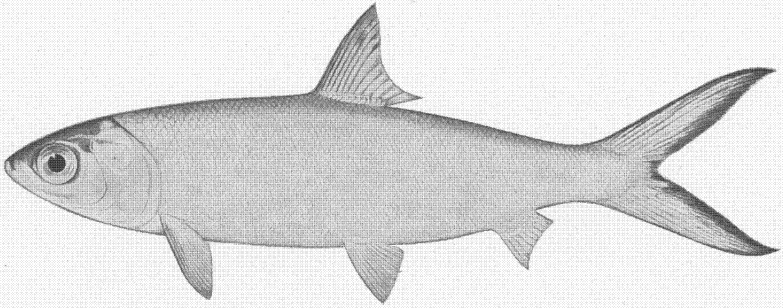


PLATE XXIV. BANGOS, MILKFISH (FAMILY CHANIDÆ). CHANOS CHANOS (FORSKÅL).

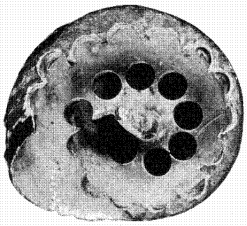


Fig. 1.

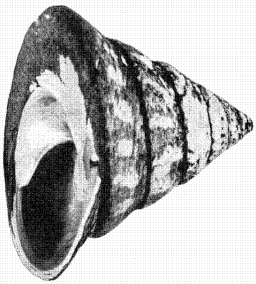


Fig. 2.

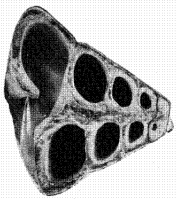


Fig. 3.

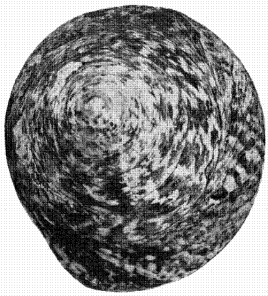


Fig. 4.

PLATE XXV. FISHERY RESOURCES OF THE PHILIPPINE ISLANDS.

can be killed by fumigation with carbon bisulphide or hydrocyanic acid gas.

26. *Garden and field crop insects.*—A very large amount of miscellaneous information is on record in this Bureau and has been disseminated regarding the prevention of the ravages of pests of garden products, such as, cabbage, asparagus, camotes, peas, corn, beets, radishes, and cucumbers; and the many purely native crops, such as, *gabi, ubi, camoting-cahoy, calabasa,* and *upo.*

27. *Silk culture.*—This Bureau introduced the culture of the polyvoltine silkworm of Ceylon in the Philippine Islands, and, besides developing a Philippine race producing at least eight generations a year, has definitely established the fact that the Japanese monovoltine silkworm cannot be acclimated here. The eri silkworm will thrive here, and an abundant supply of food for this insect exists in the castor oil plant commonly growing wild throughout the Islands.

28. *Marine biology.*—A beginning has been made in the important branch of biology which includes the study of marine products; such as, pearl oysters, window shell, edible mollusks, and edible fishes. A number of important groups of marine animals are being studied systematically, and among the more technical papers on this subject may be mentioned those on the anatomy of *Aclesia freeri* and of *Euplotes worcesteri,* the habits of fiddler crabs, and the descriptions of new species of fishes. When a sufficient amount of systematic work has been completed, we shall have a substantial basis for extended economic work and for the development of the fisheries industries.

29. *Fishery resources.*—The fishes commonly used as food have been identified, and their abundance and value noted.

A study has been made of the varieties of commercial sponges found in the Islands, and suggestions published with regard to their artificial propagation.

The species of pearl-producing mollusks have been identified, a study has been made of the existing pearling industry, and a modification of existing laws governing pearl fishing has been suggested.

Other marine products that have been studied include trepang, sharks' fins, tortoise shell, window shell, shells for buttons, precious coral, edible seaweeds, and isinglass.

30. *Ethnology.*—Our published researches in ethnology have increased the information concerning the social organizations, languages, beliefs, manners and customs, and the territory

occupied by, and the approximate number of individuals which compose, the non-Christian tribes, and have assisted in their material prosperity and their advancement in civilization.

A very comprehensive study has been made of the Ifugaos and is now in manuscript. Parts of this have been printed in papers on the harvest feast and the burial ceremony of the Kiañgan Ifugaos. Several tribes have been studied to ascertain the best methods for aiding and protecting them and for advancing their civilization. Some of the results obtained in this way have been embodied in papers on the Mañgyans of Mindoro, the Tingians of northern Luzon, the Bagobos of Davao Gulf, the Bataks of Palawan, and the non-Christians of Ambos Camarines.

Ethnology includes the study of Christian people as well as of non-Christians. Along this line a careful study of the Ilocanos has been carried on. In advance of a complete report on this subject, papers on the stone industry at San Esteban and the woodworking industry of San Vicente have been printed.

31. *Philippine museum.*—The museum of this Bureau on Calle Juan Luna contains material illustrative of the culture of most of the various groups of the Filipinos. The articles now in the museum represent the culture of the Bontocs, the Ifugaos, Isinays, Kalingas, Tingians, Mandayas, Mañgyans, Moros, Manobos, Bagobos, Yakan Moros, Subanuns, and Tirurais among the uncivilized peoples and the Ilocanos among the Christian people and a few scattered objects from odd groups. As soon as we have similar collections from the Visayans, Bicols, and Tagalogs, our collections will be fairly comprehensive and illustrative of the culture of the various groups of Filipinos.

One-half of the first floor of the museum building has been given up to the Bureau of Forestry for an exhibit of Philippine woods. The most complete and most interesting collection of Philippine woods to be seen anywhere is on exhibition here in the form of planks and logs.

Among the Bureau of Science exhibits worthy of special note are: A collection of hats, both those formerly in use and those worn at the present time; traps from various parts of the Islands for catching fish and crabs; extensive collections of weapons and implements from the Moros, Manobos, Mandayas, Ifugaos, Bontocs, and Igorots; cloths from Mindanao and from northern Luzon; basket work from the Manobos, Yakan Moros, Ifugaos, and Bontocs; and stone and silver work from the Ilocanos.

We have also a collection of Japanese and of Australian sponges, of rubber from the Straits Settlements, of Philippine

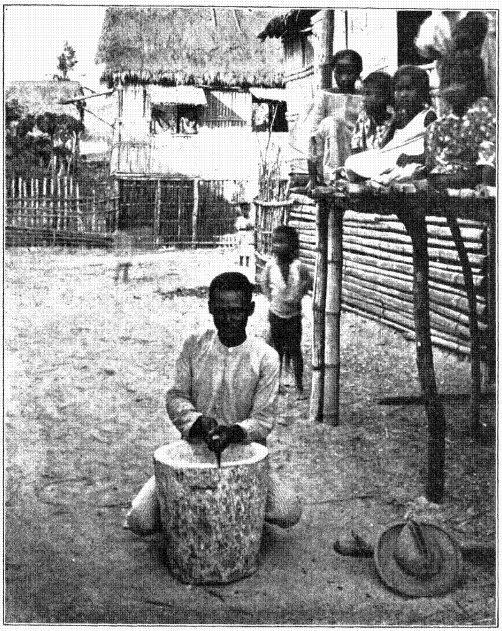


Fig. 1. Finishing a rice mortar.

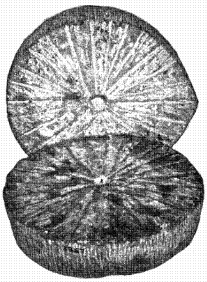


Fig. 2. Corn mill.

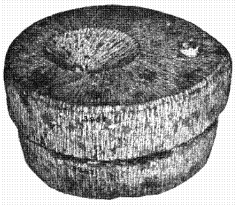


Fig. 3. Corn mill.

PLATE XXVI. THE STONE INDUSTRY AT SAN ESTEBAN, ILOCOS SUR.

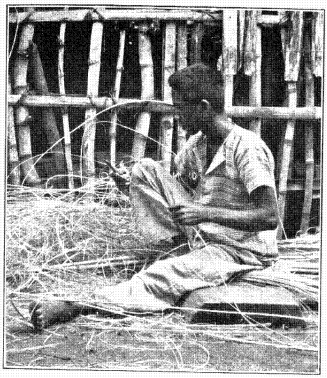


Fig. 1. Man preparing rattan.

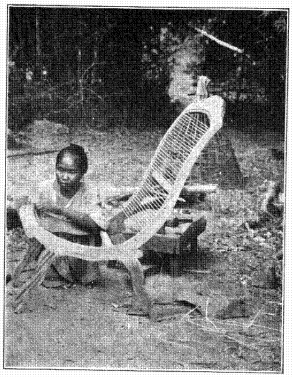


Fig. 2. Girl putting the rattan seat and back in a chair.

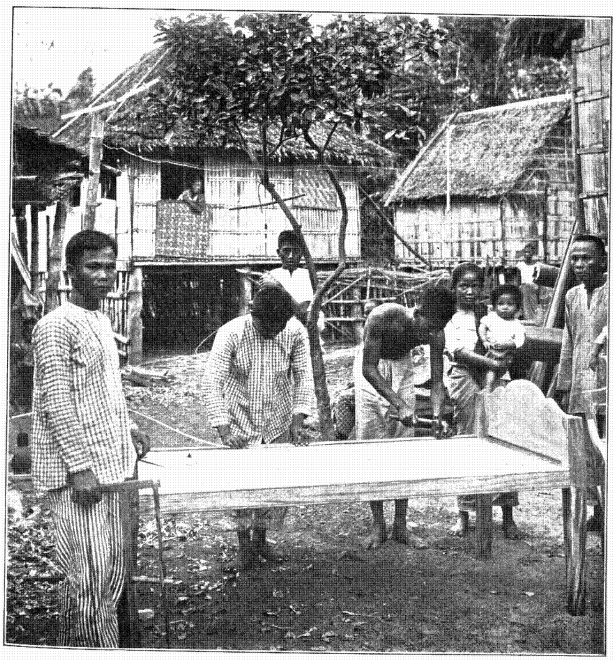


Fig. 3. Men making a bed.

PLATE XXVII. THE WOODWORKING INDUSTRY OF SAN VICENTE, ILOCOS SUR.

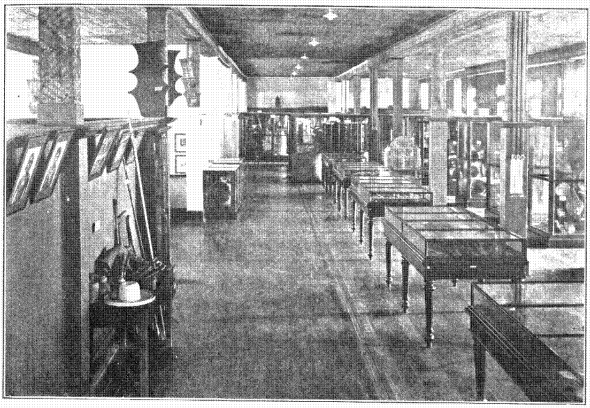


Fig. 1. Second story of museum, looking north from the center.

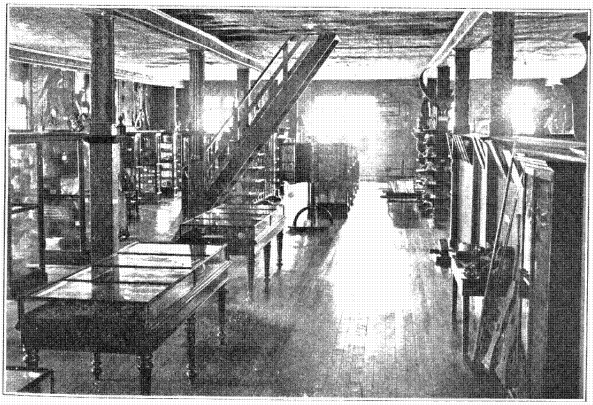


Fig. 2. Second story of museum, looking south from the center.

PLATE XXVIII.

pottery and silk, and of various chemical products from Philippine materials.

32. *Natural history specimens.*—This Bureau has established and developed the most extensive collection of Philippine birds, plants, insects, snakes, fishes, shells, and marine invertebrates extant. Many of the specimens are very beautiful, and often suggest designs for ornamentation and decoration. Their distribution may indicate climatic conditions, the course of storms and ocean currents, or the quality of the soil.

33. *Herbarium.*—The Bureau of Science is the center of botanical work on the Philippine flora. Its herbarium, which is a great card catalogue of Philippine botany from the standpoint of both systematic and economic botany, possesses the largest collection of Philippine plants extant, about 75,500, while the foreign material, chiefly from the Indo-Malayan region, brings the total collection up to about 119,000 specimens. Additions are being made at the rate of from 12,000 to 15,000 annually. The collection contains specimens of practically all the species of plants definitely known from the Archipelago, including a very large number of types and cotypes; that is, the actual specimens or duplicates of specimens on which the original descriptions of species were based.

The collections of the Bureau of Science include not only the flowering plants and ferns, but also the lower groups—mosses, scale mosses, lichens, fungi, and algæ. The market value of our present collections is at least ₱30,000, while the scientific value is infinitely greater and cannot be estimated.

34. *Economic botany.*—The subject of economic botany comprises all our coöperative work of a botanical nature with such bureaus as those of Forestry, Agriculture, and Education; the identification and regional distribution of timber trees and plants of agricultural importance; medicinal plants and investigations of the same; fiber plants; dyes and tans; oil-producing plants; those yielding gums and resins; those used in industrial work; and plant diseases and their control. Data on the constituent species of the Philippine flora, their distribution, occurrence, uses, native names, etc. are compiled in the herbarium of the Bureau of Science. The botanist is able, from an examination of our botanical records, to indicate what plants are already known from the Philippines, where they occur, when they produce flowers and fruits, their properties to a certain degree, their native names, etc.; and what plants of other tropical countries will probably thrive in the Philippines, and under what conditions

as to altitude, moisture, etc., if once introduced, and those that will probably not thrive here. A large amount of strictly economic botanical work is accomplished each year for this and other bureaus and for various individuals.

35. *Systematic botany.*—Numerous papers have been published on the botanical collections of the Bureau both by employees of the Bureau and by specialists to whom material has been sent for study and report. The total number of species of vascular plants known from the Philippines has been increased by about 2,500 in the few years that botanical work has been in progress here, so that we know at present from the Archipelago about 7,000 species. The development of the systematic work here has been necessary to the advancement of our definite knowledge of an infinite number of problems bearing on forestry, agriculture, and education. No American botanical institution is sufficiently equipped in botanical material, literature, or personnel thoroughly to cover the Philippine field, and the few European institutions so equipped are busy with the floras of other regions. The results of our systematic work, so far as the flora of the settled regions is concerned, are given in A Flora of Manila.

In connection with this work, botanical exploration is absolutely necessary, in order that we may determine what plants are found in the Philippines, whether they are of wide distribution or are of local occurrence, their habitats, and other important data. So far as practicable, it is planned to send collectors into regions that are little known botanically; that is, where no comprehensive botanical collections have previously been made. A great amount of botanical material is thus secured each year, of which the first set is deposited in the herbarium of the Bureau and the duplicates disposed of to other institutions in exchange for botanical material from other countries. Botanical exploration must precede practical application.

36. *Botanical identifications.*—Identifications of botanical material are made amounting to some thousands of specimens annually for the Bureaus of Forestry and Education and the College of Agriculture, and to a limited extent for the Bureau of Agriculture. It is impossible to estimate the financial value of these identifications. The privilege is open to all bureaus.

37. *Mycology.*—These investigations are most important from an economic standpoint. They include the collection and determination of the different kinds of fungi, and the special branch, vegetable pathology, which comprises the study of the fungi causing the diseases of plants and methods of preventing and

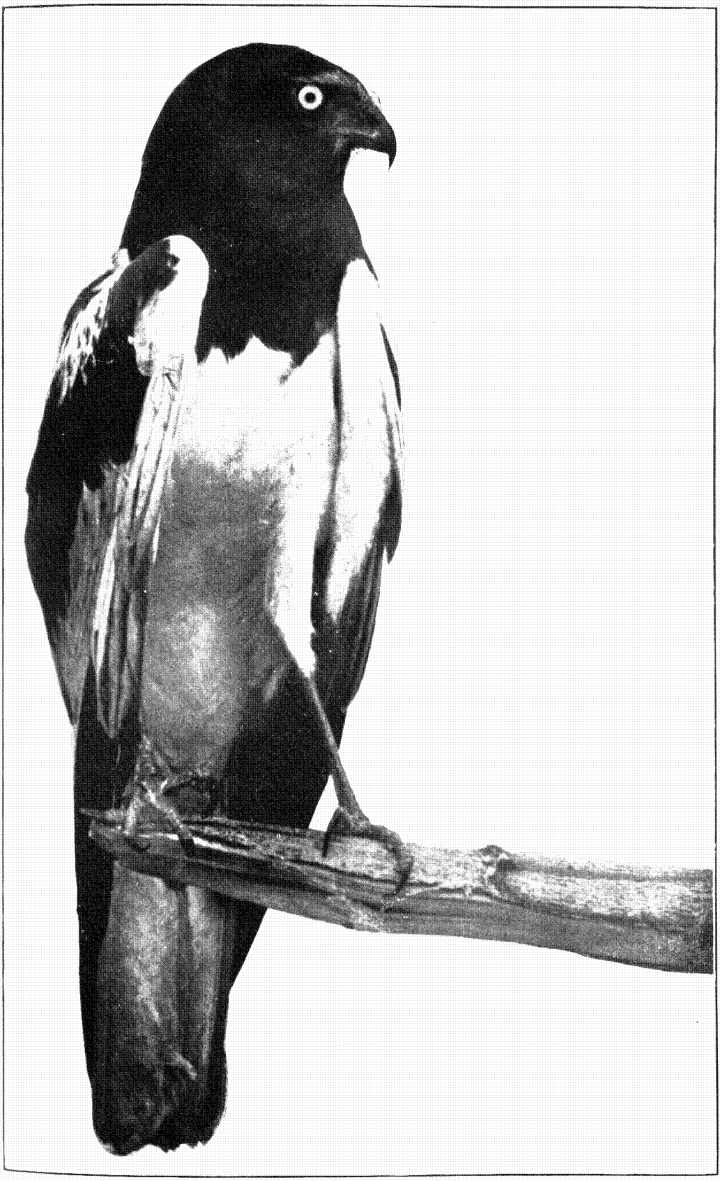


PLATE XXIX. CIRCUS MELANOLEUCUS (FORSTER).

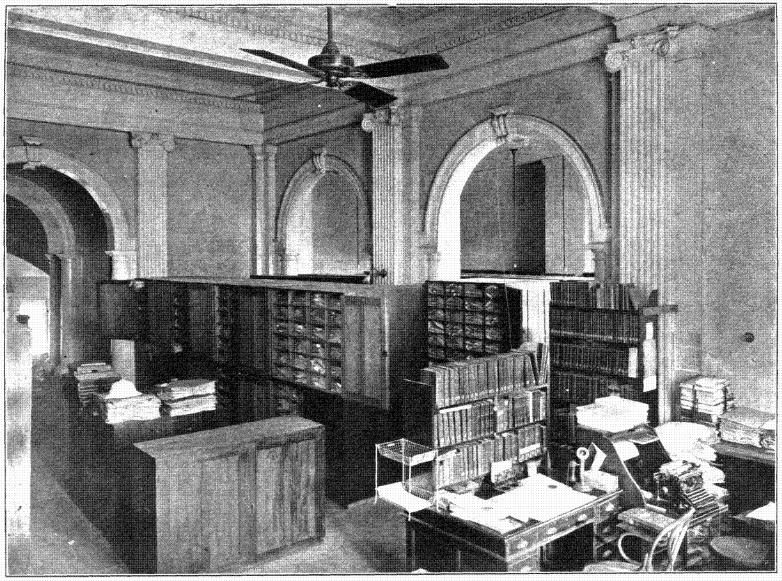


PLATE XXX. INTERIOR OF HERBARIUM, SHOWING TYPE OF CASES.

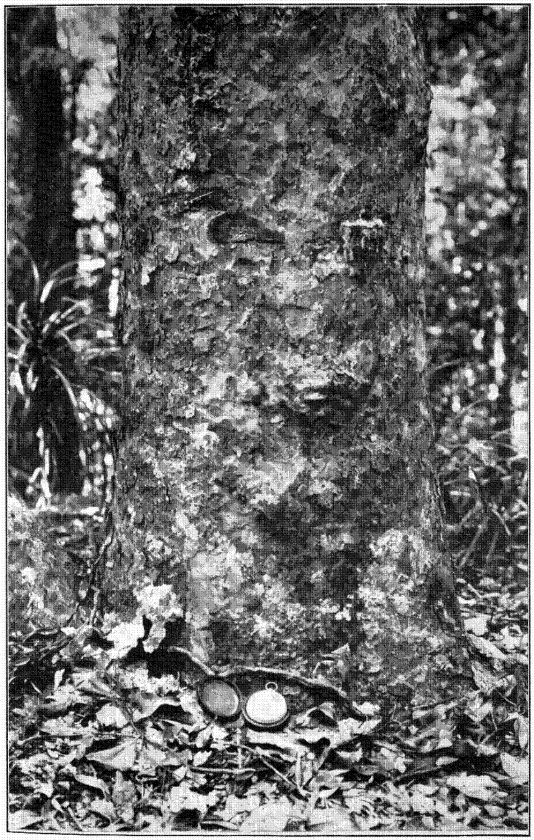


PLATE XXXI. TRUNK OF AN ALMACIGA TREE (AGATHIS ALBA FOXW.).

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in forestry is given, is located near the reserve, and students do most of their field work in the reserve. The botanical results will be available to students both of forestry and of agriculture.

41. *Forestry.*—The matter of the correct classification of commercial timber trees is one of great importance to the forester, especially in the Philippines where we have such an immense number of trees—about 2,500 species. Only a small percentage of these, however, is of commercial value. With the correct identification of the species, as made by this Bureau, the foresters have been able to refer the names of the various timber trees to a standard nomenclature and thus have been able to reduce the infinite number of native names as synonyms to selected standard names and our scientists have been able especially to correlate the commercial Philippine timbers with similar or allied forms in other parts of the Indo-Malayan region.

42. *Horticulture.*—In order to help stimulate local interest among Government officials and private citizens in the matter of the selection, propagation, and care of ornamental plants and shade trees, considerable attention has been given to this phase of horticulture, two editions of a descriptive catalogue of the plants cultivated in the city nursery at the Cementerio del Norte have been prepared, and an article on selected shade trees and their care prepared and published in the Quarterly Bulletin of the Bureau of Public Works. Through exchanges arranged by the Bureau of Science, seeds of numerous ornamental palms and other plants have been received from foreign countries for propagation here.

43. *Mango bud-blight.*—In the Philippines there is a mango bud-blight which attacks the mango flowers at about the time they are opening, grows over them, and causes them to become abortive and fail to set fruit. The attention of growers has repeatedly been called to the fact that, if they would take the trouble to spray the trees with a weak Bordeaux mixture at the time of flowering, a good crop could be obtained.

44. *Hats and hat-making materials.*—Investigations have been made and published on the different types of hats manufactured, their characteristics, the materials of which they are made, how the materials are prepared, and where they are secured. The published article also takes into consideration the grades of hats and the centers of the hat-making industry in the Philippines. This subject is one of considerable commercial importance, for the manufacture and export of hats from the Philippines is a comparatively large industry.

45. *Medicinal plants.*—A very large number of plants are used

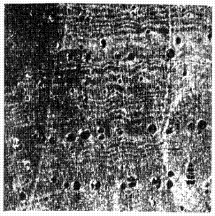


Fig. 1. Narra.

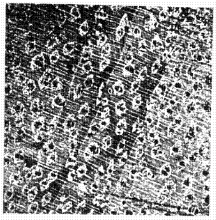


Fig. 2. Ipil.

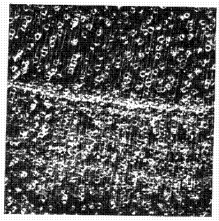


Fig. 3. Guijo.

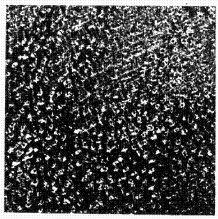


Fig. 4. Macaasin.

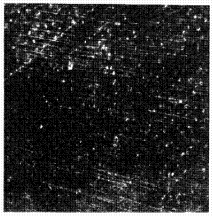


Fig. 5. Mancano.

Fig. 6. Station for investigations on plant physiology, Mount Maquiling. Shelter for self-recording hygrometer.

PLATE XXXII.

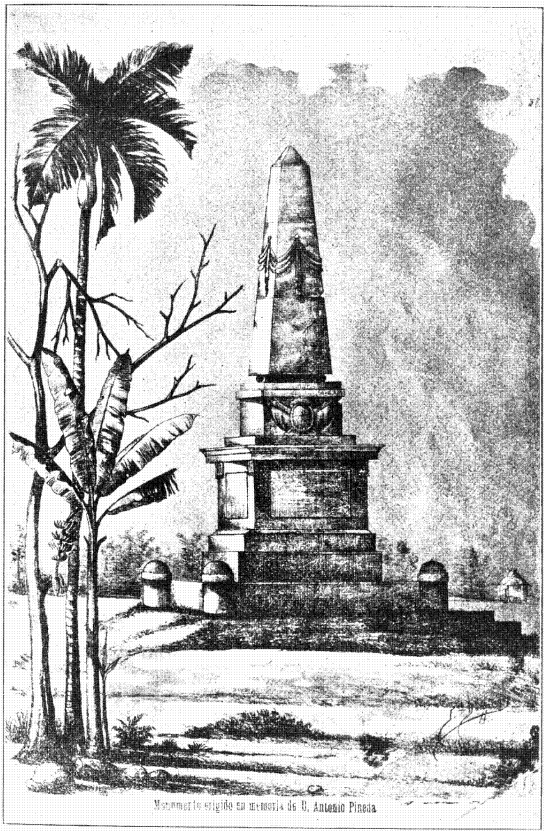


PLATE XXXIII. THE PINEDA MONUMENT.

PLATE XXXIV. DRIVEWAY AT CEMENTERIO DEL NORTE, MANILA.

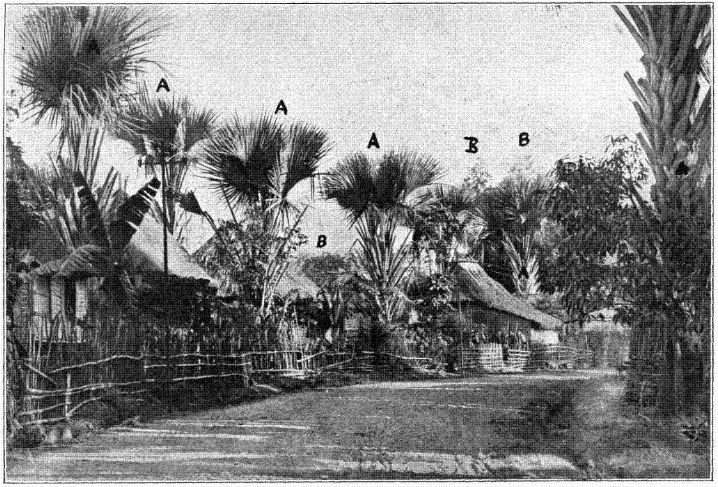


PLATE XXXV. VIEW IN PANGASINAN PROVINCE, SHOWING BURI PALM (A) AND BAMBOO (B).

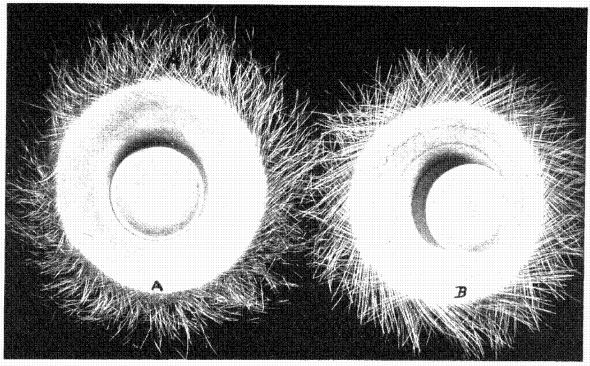


Fig. 1. Outer and inner halves of one Calasiao hat.

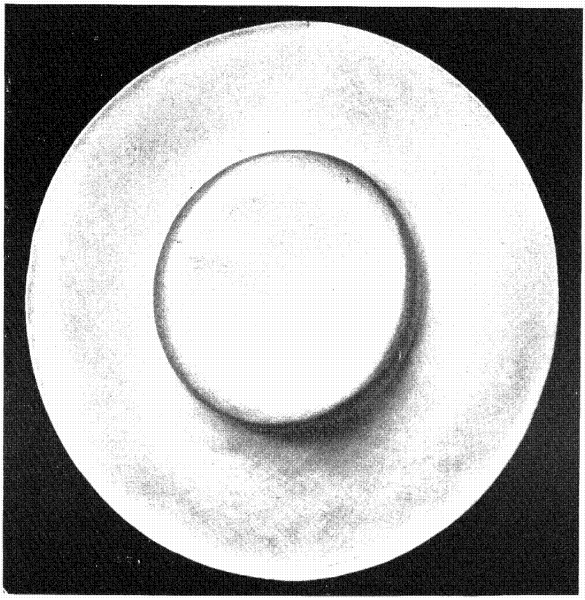


Fig. 2. Completed buri-midrib (Calasiao) hat.

PLATE XXXVI.

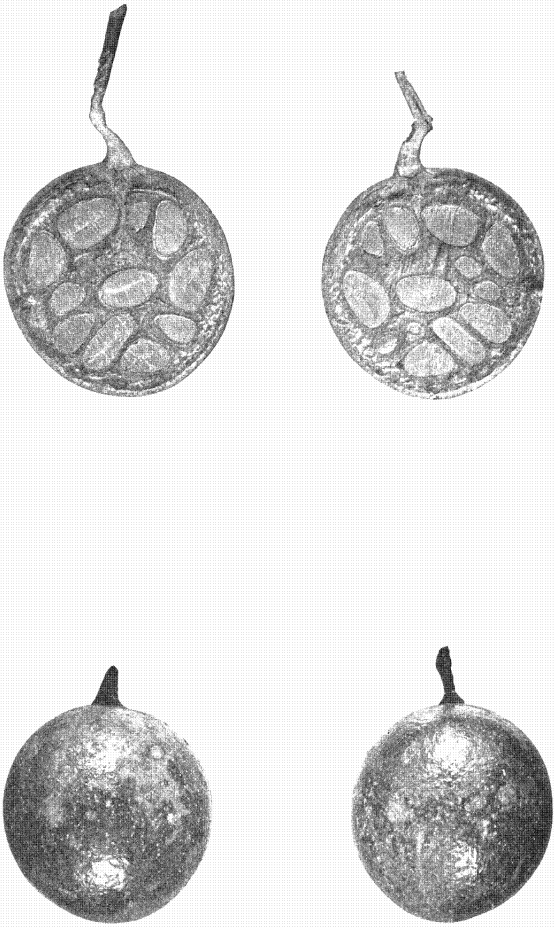


PLATE XXXVII. FRUIT OF ST. IGNATIUS BEAN (STRYCHNOS IGNATII BERG.).

A strychnine-producing plant known only from the Philippine Islands.

by the natives in the treatment of diseases. Some of these plants have important properties that are thoroughly understood, and a few are recognized as the sources of various medicines in the standard pharmacopœia. A still larger number remain to be investigated, in order to prove or disprove their reputed medicinal qualities. The active constituents of many medicinal plants growing in the Islands have been isolated and identified. *Dita, Datura, sibucao, macabuhay, bonduc,* purging oils, and the fish and arrow poisons may be mentioned as illustrating our work along this line.

46. *Tans and dyes.*—The assessed value of tanning materials imported into the United States in 1910 exceeded $6,500,000, and European tanners each year are becoming more dependent upon imported materials. Data collected by the Bureau of Science show that Philippine mangrove barks of the better species contain about 30 per cent of tannin and indicate that a net profit of from ₱50 to ₱60 per ton can be made on tanning materials derived from the mangrove swamps of the Philippine Islands. There are areas of workable swamps in the Islands capable of producing 1,500 metric tons of extract yearly, having a value of ₱210,000. The exploitation of these swamps would involve a firewood and piling industry of about an equal magnitude.

Many local species of plants yield dyes. These vegetable dyes are of comparatively little importance commercially, as most of them have been replaced by aniline dyes.

47. *Paper pulp.*—This Bureau has carried on for several years investigations of bamboo, cogon, abacá or hemp, and various palm fibers as materials suitable for the commercial manufacture of paper. The data collected have been accurately interpreted with due regard to the local conditions bearing upon the subject, and show that an industry of great potential economic value can be developed. Careful surveys of some of the bamboo fields available have been made. Sufficient data with regard to the cost of the raw material, the quantity of bamboo available, the cost of manufacture of the pulp, etc., are given to show that the bamboo soda pulp can be developed into a profitable export trade in direct competition with chemical wood pulp at present quotations. Other countries have appreciated the work done by the Bureau of Science, and our work will undoubtedly be the means of starting the paper industry in the Philippines at some future time.

48. *Coconuts.*—The solution of the many problems relating to coconuts, copra, and coconut oil is of vital importance to the progress and success of this industry. The production and value

of the Philippine coconut will continue to increase, and intelligent control must be based upon careful scientific investigation. The results of our work on the subject have been published from time to time as various phases were completed. These have included the water relation of the coconut palm, the relation of the coconut and the production of coconut oil and that between the location of the palm and oil content of the nut, the hydrolysis and subsequent destruction of fat, methods of drying, insect pests and preventive measures, the influence of sprouting on the copra and oil, methods of analysis, effects of feeding copra cake as cattle food, the purification of coconut oil and its detection as an adulterant in other oils, and the deterioration of copra during storage. To a large extent it is possible to determine beforehand from a simple examination of the vegetation in connection with the recorded distribution of rainfall, whether or not coconuts will thrive in a particular locality. Experiments have proved that the coconut tree can be kept practically free from the attacks of its only serious pests, the *uang* (*Oryctes rhinoceros*) and the weevil (*Rhynchophorus ferrugineus*), by keeping the coconut groves clear of dead and decaying trees and rubbish and by allowing the dead leaf-petioles to fall naturally. The work is being continued, and results will be published as they become available.

49. *Sugar.*—A press bulletin has been issued which shows the financial loss occasioned by the harvesting of unripe sugar cane and which demonstrates that an actual loss can be converted into a material gain if proper instructions are followed. Tests of sugar cane made in India with regard to the loss in value of the crop due to the disease "red-rot" show a diminution of 45 per cent in available sugar. This Bureau has demonstrated that red-rot is more or less prevalent in the Philippines, and the attention of planters has been called to the fact that they should take advantage of the data and be careful to select seed cane and weed out that which has become diseased. Sugar cane is singularly free from pests except when a region is temporarily infested by locusts. In certain regions where intensive culture has been started in recent years, the leaf hopper has proved very destructive at times, but suggestions from this Bureau as to cleaner methods of harvesting, together with allowing certain parasites of these pests to develop before the cane is cut, have undoubtedly done much to lessen the destruction of sugar cane. Other pests which may develop in importance are being studied. Reliable information concerning the conditions of agricultural

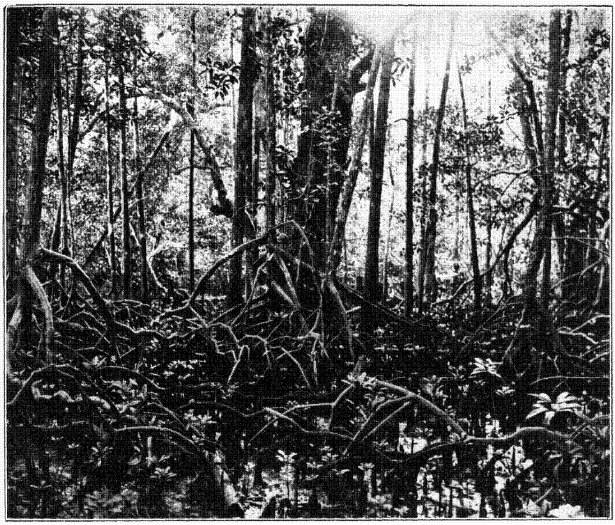


Fig. 1. Interior view of a mangrove swamp.

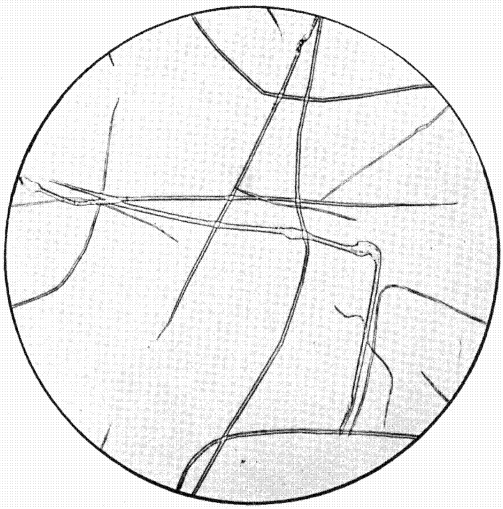


Fig. 2. Dwarf bamboo (Bambusa blumeana Schultes f.). Fibers seen longitudinally.

PLATE XXXVIII.

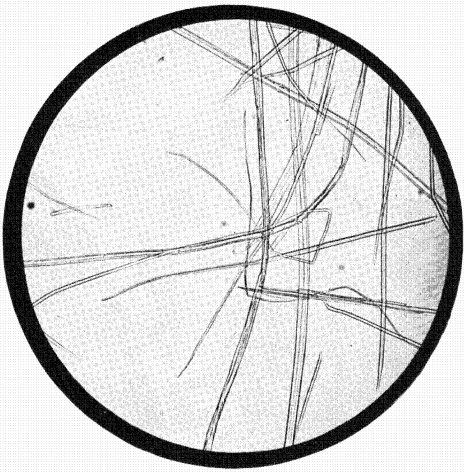


Fig. 1. Cogon (Imperata exaltata Brongn.). Fibers seen longitudinally.

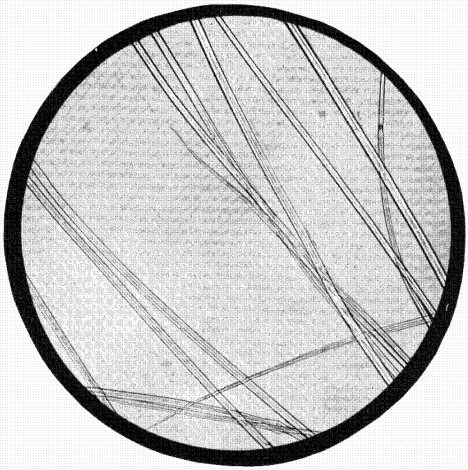


Fig. 2. Abacá (Musa textilis Née). Fibers seen longitudinally.

PLATE XXXIX.

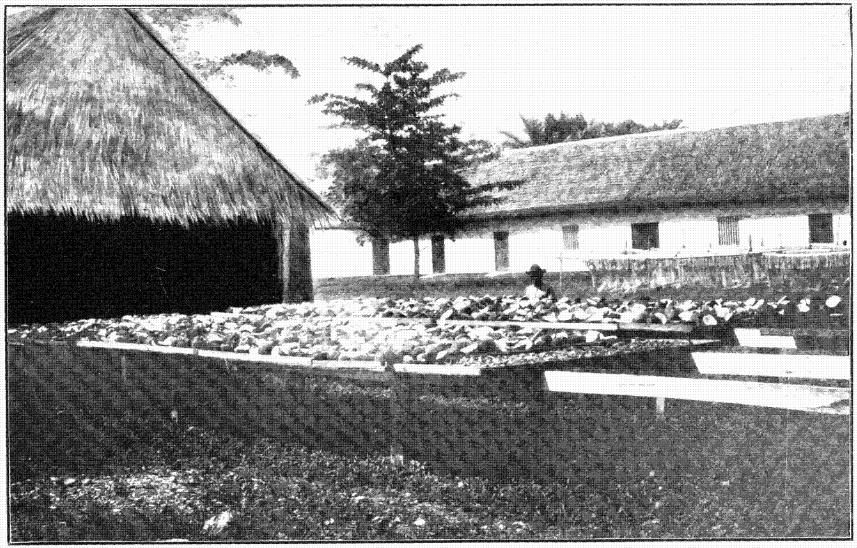


PLATE XL. SUN-DRYING COPRA, SHOWING COCONUTS ON TRAYS, READY TO BE PUSHED UNDER THE SHELTER.

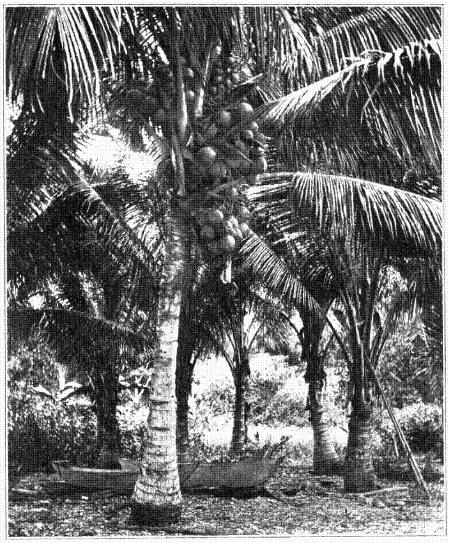


Fig. 1. Coconuts, Mindanao.

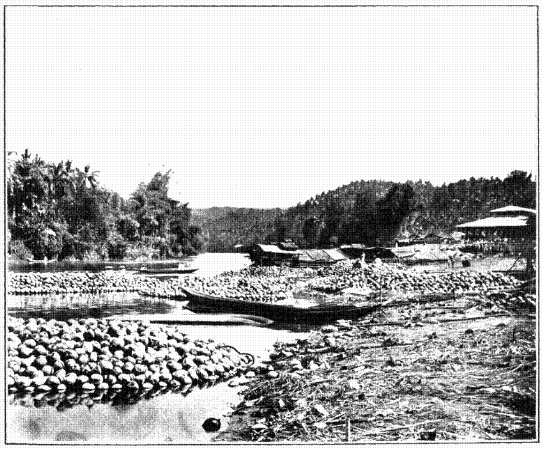


Fig. 2. Coconuts rafted down a river.

PLATE XLI.

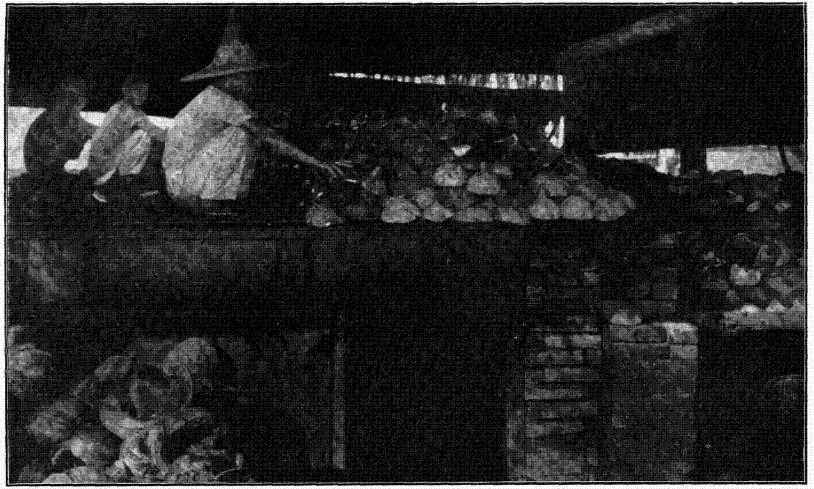


PLATE XLII. KILN DRYING; THE HALVES OF THE COCONUTS ARE PLACED OVER THE GRILL FOR THE PRELIMINARY DRYING.

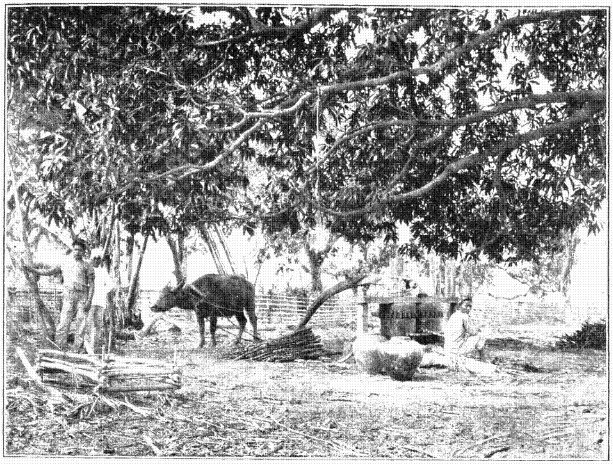


Fig. 1. Cane crusher near Agoo, La Union Province.

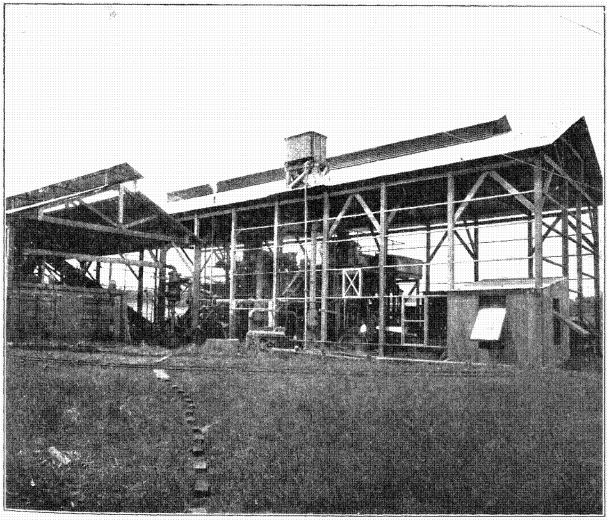


Fig. 2. A modern sugar mill.

PLATE XLIII.

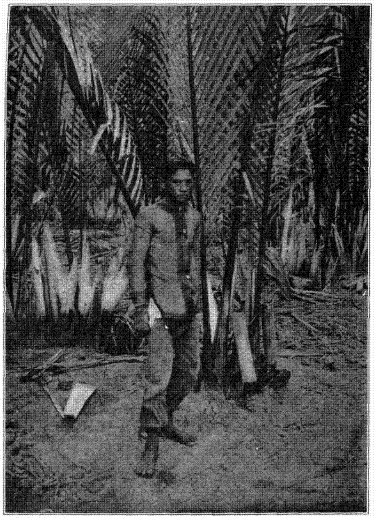


Fig. 1. Collecting nipa sap.

PLATE XLIV.

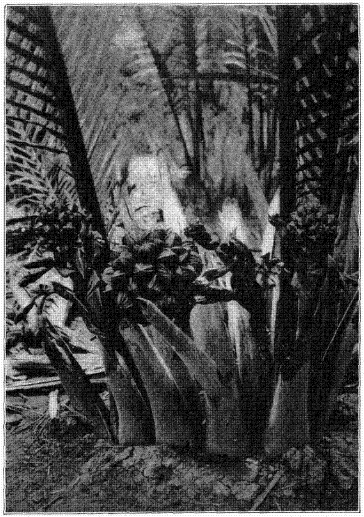


Fig. 2. Nipa palms in fruit.

practice in cane growing and sugar making, prevailing in various parts of the Philippine Islands, has been collected. Part of this has been published in a monograph of the Bureau of Science, entitled The Sugar Industry in the Island of Negros, by H. S. Walker.

50. *Sugar from palm saps.*—It has long been known that a large number of palm trees secrete a sap rich in sugar, and the natives of various countries have taken advantage of this fact to supply themselves with limited amounts of this commodity. No exportation on a commercial scale has been attempted for the reason that it promised no financial returns.

We have found in the nipa palm, which grows extensively in a number of places in the Philippine Islands, covering large swamp areas which would otherwise be waste, a source of sugar which has been proved to be very attractive from the standpoint of investment. The sap, as it flows from the palm, has approximately the composition of the sap of the sugar cane, and we have developed methods for its collection and preservation during transportation to the refinery. The difficulties encountered for the establishment of the business upon a large commercial scale have been entirely overcome through our investigations. The results of this work will be published in Section A of The Philippine Journal of Science of this year.

This marks the establishment of an industry new to the world, and one which will be unique to the Philippine Islands and give employment to a large number of Filipinos.

51. *Alcohol.*—Suggestions have been made for increasing the yield of alcohol by improving the existing methods of manufacture. In extreme cases the present available loss is very high. [The Philippine Journal of Science, Section A (1911), 6, 136–206.]

52. *Essential oils and terpenes.*—The most important essential oils and terpenes have been studied, and their commercial value discussed. This rather comprehensive investigation has shown that excellent turpentine and colophony (practically identical with those from American pines) may be produced from the plentiful pines of Benguet. The various resins, such as elemi, balao, apitong, and copal, have been investigated both from the scientific standpoint of their chemical composition and from the practical consideration of their use in the manufacture of varnish etc. The essential oils responsible for the fragrance of many plants and flowers have also received considerable attention. Among these may be mentioned ylang-ylang, champaca,

orange, lemon grass, vetiver, cinnamon, and ginger. Several of these have commercial application in the perfume industry and others in the manufacture of nonalcoholic beverages and fruit flavors. Other oils investigated during the past few years comprise lumbang or candlenut, kapok, cashew, castor, cotton seed, and physic nut. These represent a type derived from oil-bearing seeds, and have a commercial importance of considerable magnitude.

53. *Philippine foodstuffs.*—The many unique and characteristic foodstuffs used by the native population have received attention, as well as the citrus and other fruits. The nutritive value of these products is now known, and is available for studying dietary questions of great practical importance. All varieties of canned milks entering the Islands, as well as fresh cows', goats', and carabaos' milks, have been included in this study. The importance of this question in controlling and reducing the high infant mortality can hardly be overestimated. All data collected regarding food products are, moreover, of utility in preparing standards for, and in enforcing, the Pure Food and Drugs Act to protect the health and welfare of the public.

54. *Opium.*—The prevalence of opium and other drugs used contrary to law in many sections more than justifies the researches carried on regarding their detection and characteristics.

55. *Water.*—This Bureau has made over 1,100 chemical and bacteriological examinations of waters from various sources of local supply. We have made thorough examinations of waters from springs, dug wells, drilled wells, rivers, reservoirs, cisterns, etc.; and have passed judgment upon their state of pollution or potability, their suitability for domestic and industrial use, or their medicinal value. The question of health in the tropics is largely a question of proper sanitation, and its principal adjunct is a good, potable, nonpolluted water supply. The purity of the water supply is also an important direct financial consideration, and, although few realize the great difference between the commercial values of hard and soft water, large savings have been effected by the substitution of a soft for a hard water supply even at the cost of preliminary treatment.

56. *Soils.*—The chemical and physical properties of Philippine soils, and also some of the conditions which influence them, such as, rainfall, humidity, the maximum and minimum air temperatures, the temperature under the surface, the amount of light and sunshine, winds and the evaporation of the soil moisture, exposure, and altitude, have been taken into account. All these

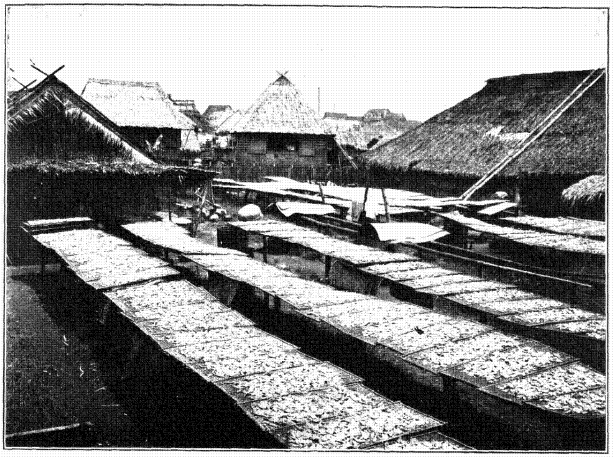


Fig. 1. Fish drying in the sun.

Fig. 2. Opium den.

PLATE XLV.

factors influence the soil, and a most intelligent and thorough understanding and systematization of them is necessary to obtain the best results, for at a given time any one of these may become a controlling factor in the production of a crop. Because of the more or less crude methods of cultivation in use throughout the Archipelago, it has not always been easy to determine whether the chemical or the cultural elements are the limiting factors.

Hundreds of soils from the more important agricultural regions of Luzon and other islands have been analyzed, and show that different sections vary in their chemical and physical compositions. Eventually, these analyses will form a basis for more extended work on methods of fertilization and production of special crops adapted to the different localities. This information in conjunction with data concerning the crops grown may give information regarding the needs of the soil and the kind of crops adapted to a particular region.

This Bureau has been able to supply information concerning the potential fertility of the soil, ease of plowing, drainage, and consequent effect upon bacterial development. We have been able to predict the soil constituents that would be exhausted in the course of crop production and to indicate the proper fertilizers as well as the abundant elements of plant food that would not need to be supplied by fertilization.

In the absence of more authentic data, it is possible to judge by an examination of the vegetation whether important crops, such as coconuts, abacá, maguey, rubber, and tobacco, will thrive in a particular locality. Where certain species of plants are dominant, there is a prolonged dry season; where the rainfall is continuous, more vigorous species crowd them out. Full data are not yet available on the exact types of vegetation indicating the probable success or failure of all of these crops, but in general the presence or absence of certain native species in a given region well indicates what cultivated plants may be expected to thrive and what in all probability will not thrive. From a commercial standpoint, the importance of this is very great, for no individual should risk the loss of money in the establishment of plantations in regions where it is practically certain that his particular crop will not thrive.

57. *Fertilizers.*—In recent years the exploitation of the guanos of the Islands has been attempted, and the Bureau has been called upon to analyze and give necessary information concerning their possible commercial value. Data and analyses concerning a considerable number of guanos have been published in order to

indicate what may be expected of the deposits in the different parts of the Archipelago.

At times the Bureau has been called upon to determine the utility of certain substances as fertilizers, their method of application, and to adjust conflicts of analyses between buyer and seller.

58. *Salt.*—The Bureau of Science has taken up the study of the salt industry and resources of the Philippine Islands. Salt is produced by the use of solar heat or, in limited quantities, by the use of direct artificial heat. The methods employed for the preparation of salt from sea water by the use of solar heat are very crude, and the method now most commonly employed is probably the original one used in these Islands. In recent years the Chinese have introduced a somewhat improved method.

The people of Mountain Province produce a small amount of a poor grade of salt by evaporating water from carbonated springs. At Mainit, Bontoc; Tukukan, Ahin, and Bungabungna, Ifugao; and Salinas, Nueva Vizcaya, the supplies of brine vary in quantity and strength. The resources of these springs should be developed in order adequately to supply Mountain Province with salt at a reasonable price.

In round numbers 20,000,000 kilograms of crude salt are produced annually. Scientific study of this industry will indicate how to increase the output of each individual employed and to improve the quality of the product.

59. *Sunlight.*—The study of sunlight and its effect upon chemicals and animals has been carried on for a period of over five years. The work so far has shown that the injury attributed to the actinic rays of the sun is greatly exaggerated, and that if these so-called actinic rays are injurious in the tropics they are equally so on clear days in the other portions of the world. Some effects of sunlight upon individuals whose skins do not furnish the proper protection due to lack of pigmentation have shown that certain reactions seriously affecting the health of the individual may occur. Comparisons of sunlight intensities determined at our suggestion by means of a chemical photometer at various places, including Manila, Baguio, Kuala Lumpur, Honolulu, Khartoum, Washington, Munich, and several places in Australia have been made. These show that on clear days at many of the places investigated the rate of reaction is practically the same; therefore, the normal sunlight intensities throughout the various regions of the earth are practically identical.

It has been found that sunlight produces effects on a large

Fig. 1. A leaching vat built on the ground, but high enough so that the mud may be removed by gravity after the leaching is completed.

Fig. 2. A more developed and more progressive type of leach. A kind of cultivator used in loosening the soil is also shown.

PLATE XLVI.

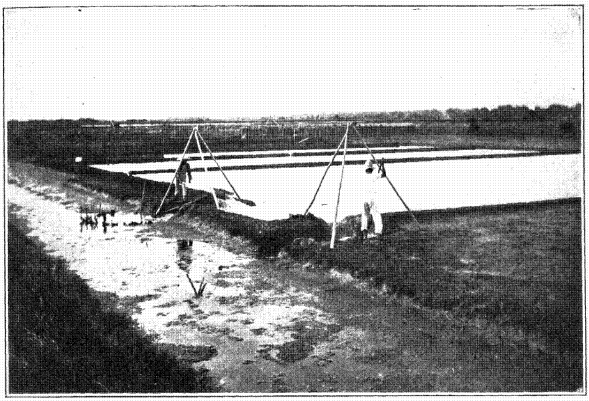


Fig. 1. Showing the apparatus for transferring brine from evaporating reservoirs to crystallizing vats which are on a higher level.

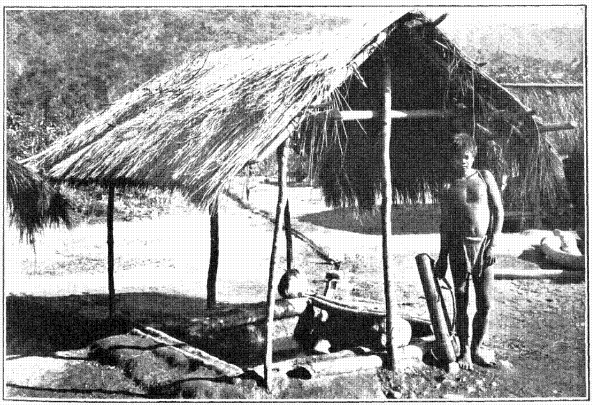


Fig. 2. The lower end of a bamboo trough from the Salinas salt springs, showing the well from which the brine is carried to the evaporating pans.

PLATE XLVII.

number of pure chemicals heretofore unsuspected. Many new chemical reactions in sunlight and the mechanism concerning a number of old ones have been discovered.

60. *Standardization and testing of supplies.*—This Bureau has long maintained a laboratory for the purpose of testing and analyzing the various products purchased under contract for Government supplies. We have tested numerous samples of bituminous and metallic roofing materials for the United States Army; and khaki, shirts, puttees, rain capes, blankets, leather goods, paints, iron and steel, rope, wire, twine, paper, oils, canvas, Babbitt metals, alloys, tiles, bricks, concrete, fabrics, etc. for the local Government. The scope and work of this department have shown a decided increase during recent years, owing largely to a growing realization of the value and necessity of purchasing materials on a basis of quality or, at least, according to specified requirements which will guarantee satisfactory service. Usually, when the testing of a certain class of material is first instituted, the samples submitted give very unsatisfactory results, and immediately the manufacturers protest vigorously and complain that the tests are impractical or the testing improperly done and unfair. However, it is a matter of record that when specifications are rigidly enforced, most of the materials subsequently submitted are so uniformly excellent that it is difficult to decide in favor of any particular one. The records also show that the improvement in quality is usually obtained without an increase in cost.

61. *Asphalts, bitumen, tars, and oils for road materials.*—This Bureau in conjunction with the Bureau of Public Works has given considerable attention to the physical and chemical properties of bituminous road materials. Careful inspection and examination both of the materials employed and their durability under different local conditions of climate and service will give information of much value and will determine their suitability for use according to various methods of application and construction.

62. *Portland cement.*—For the past five years our investigators have carried on painstaking observations and careful experimental work to study the technology of manufacturing, testing, and use of Portland cement. Those characteristics of Portland cement, regarding which there existed the greatest amount of misconception and diversity of opinion, were studied in an endeavor to assist in the universal effort to formulate cement specifications so drawn as to guarantee the manufacture and use of Portland cement of the quality sought for, and the work of

the investigators has given us a more reliable product in the Philippine Islands. The importance in relation to safe construction and to the saving of money to be effected by carrying on such work is very great. During one fiscal year, 71,778,675 kilograms, or a value of ₱1,524,600, of Portland cement were imported into the Philippine Islands. At a low estimate the total cost of the corresponding concrete was six times the cost of the cement, or ₱9,147,600. A gain or loss of 1 per cent in the efficiency of this material in durability and strength represents a money value of ₱91,476.

Our investigation proved that the efficiency of Portland cement is obtained at a corresponding expense to the manufacturer, and cements should be purchased on a basis of quality rather than upon a mere consideration of quantity, and the information gained from this research work enabled us to suggest "a bonus system for the purchase of Portland cement," the enforcement of which, it is believed, would secure the best cement at a reasonable cost and eliminate the necessity of occasionally rejecting cements as has heretofore occurred.

Our investigations with regard to the manufacture of Portland cement from local raw materials have proved that there is an abundance of calcareous and siliceous material in certain desirable localities which are well suited for the manufacture of Portland cement on a commercial scale. As there is no cement plant in the Philippine Islands, all of the Portland cement used in this country has been imported, and the high cost for shipping and transportation makes our concrete construction expensive. The average cost of Portland cement in the United States is about ₱2 per barrel, but the local Government on large contracts now pays from ₱5.50 to ₱6.50 per barrel.

63. *Concrete.*—Careful, systematic inspection of the sand, gravel, and stone, as well as of the cement used in all concrete construction, is necessary to secure satisfactory permanent results, and reliable and economic practice in concrete construction cannot be assured until the quality and concrete efficiency of the available aggregates—sands, gravels, and crushed stones—have been thoroughly investigated. The Bureau of Science has shown that many of the aggregates which have been used for this purpose are of poor quality, and that adequate consideration is not given to the fact that the nature of the aggregate is fully as important as the quality of the cement. Our investigations indicate the necessity of adopting standard methods for testing concrete and aggregates and a thorough and systematic study

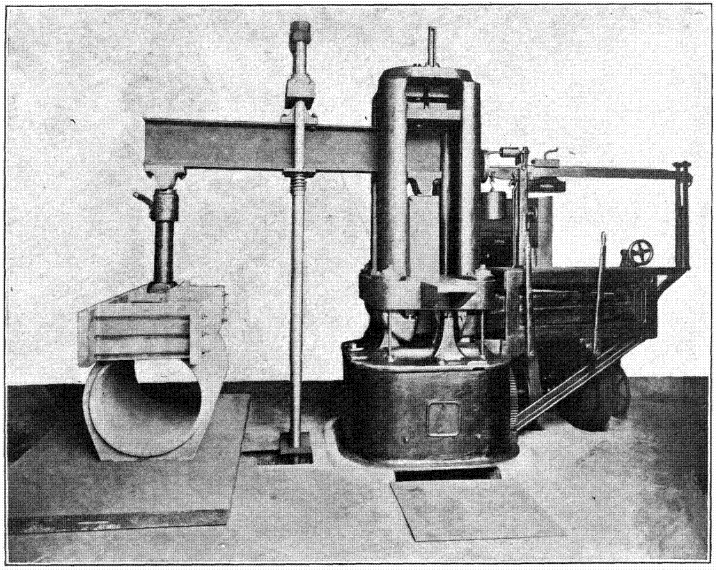


PLATE XLVIII. TESTING MACHINE BREAKING CONCRETE PIPES.

PLATE XLIX. PORTLAND CEMENT MANUFACTURED FROM PHILIPPINE RAW MATERIALS, SHOWING PERFECT SOUNDNESS OF FOUR DIFFERENT MIXTURES FROM ONE DISTRICT.

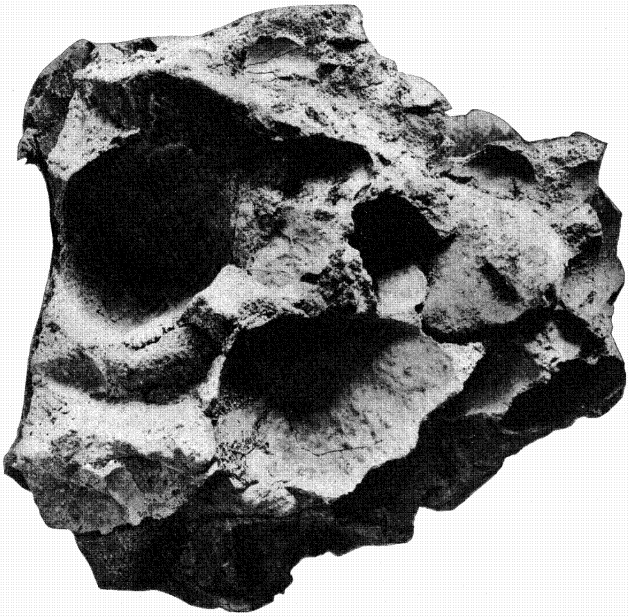


PLATE L. CONE FROM CRUSHED CUBE OF CONCRETE FROM ABATAN RIVER, CORTES, BOHOL, SHOWING EFFECT OF USING GRAVEL COVERED WITH GREEN ALGÆ.

of the most promising Philippine materials which are available for concrete work in different localities.

64. *Nonmetallic deposits.*—Field investigations have revealed the existence of materials suitable for various purposes and of economic importance; for example, asbestos and sulphur deposits; limestones; sand; volcanic tuff and ash; clays and shales suitable for the manufacture of Portland cement, hydraulic cement, sand-lime brick, vitrified brick, refractory ware, and pottery; and stone suitable for lithographic purposes. In the calendar year 1912 the importations of china-, earthern-, and stoneware alone amounted to ₱391,852, of which 50 per cent could easily be produced in the Philippines. The importations of Portland cement for the same period amounted to ₱1,136,456.

65. *Sand-lime brick and artificial sandstones.*—A study of available local materials and conditions showed that the latter in the Philippines are very favorable for the manufacture of brick and artificial stone from sand and lime; that the best location for the first plant is probably in the vicinity of Manila near Pasig River at Guadalupe; that strong, dense, durable, impermeable, and practically fireproof sandstone could be made by the steaming process from sands from Manila beach, Pasig River, and Orani River, and from Tarlac volcanic tuff, quarry débris from Sisiman (andesite), or Talim (basalt) rock; that the beach sand was the most economic material; that beautiful polished "marbles" could be manufactured from the quarry débris; that the cost of manufacturing and selling 9-inch bricks of the best quality would not exceed ₱13 per thousand; and that the profit of a plant could be increased by extending its operation to include the manufacture of lime, hollow building blocks, tiles, slabs, marbles, ornamental stones, etc. We are now investigating the available raw materials in the vicinity of Cebu, and hope eventually to include the vicinities of Iloilo, Zamboanga, and Jolo.

66. *Vitrified brick.*—We have made pressed and vitrified brick from Philippine materials which have given very promising results. The local manufacture of this product would be of great financial importance.

67. *Quarries.*—The city of Manila uses about 50,000 cubic meters of crushed stone each year for surfacing streets. A recent investigation of Laguna stone-quarries by a special committee which included a geologist of this Bureau has shown that a much better rock could be secured and with an actual annual saving of at least ₱21,000 to the city of Manila, besides a considerable saving in maintenance.

The Bureau of Science is equipped with apparatus for determining the relative value of various kinds of stone for macadamizing streets by submitting them to an abrasion test and determining their cementation value, toughness, absorption, hardness, specific gravity, and strength. Over 800 samples of stone from different parts of the Islands have been tested.

68. *Coal.*—The Bureau of Science has made geologic reconnaissances of all the better known coal localities, as well as a study of their physical and chemical characteristics. The data secured relate to the topography, transportation, labor, timber, age and character of the formations, physical properties, chemical analyses, calorimetric value, coking qualities, oxidation, deterioration, slacking, spontaneous combustion, storage, utilization, the comparison with other coals on the market, etc. Data concerning all features connected with coal from its discovery and development to its most economical utilization, which will assist commercial concerns, have been given. Geologic studies have revealed the position, number, and relations of various seams found in the scattered outcrops as well as of deposits not outcropping on the surface, by the application of paleontologic principles. The existence and extent of faulting and other disturbing features have been studied. Chemical studies show that certain coals which are subject to air slacking and spontaneous combustion can be stored in a manner such that their physical integrity is maintained, avoiding great loses and possible conflagration.

69. *Producer-gas plant.*—Investigations show that certain Philippine coals are not wholly satisfactory, *a priori,* as steaming coals. This Bureau now has a 67-horsepower producer-gas unit with the corresponding engine and electric generator direct coupled. Coal from East Batan Island has been used exclusively for this plant, and experiments have demonstrated its excellent adaptability to this purpose. Philippine coal burned in the producer unit is 50 per cent more efficient in the production of electric power than the Japanese coal burned under a steam boiler. It is probable that the poorest coals employed in a producer-gas plant may become as valuable as the best grades of coal used in a steam plant or, perhaps, even supersede the steam plant altogether for stationary work.

70. *Petroleum.*—Samples of petroleum have been collected from Philippine formations. The geology has been worked out in one field in sufficient detail to enable us to see that the structure is favorable for the accumulation of commercial quantities of oil. Various authentic samples have been studied, and

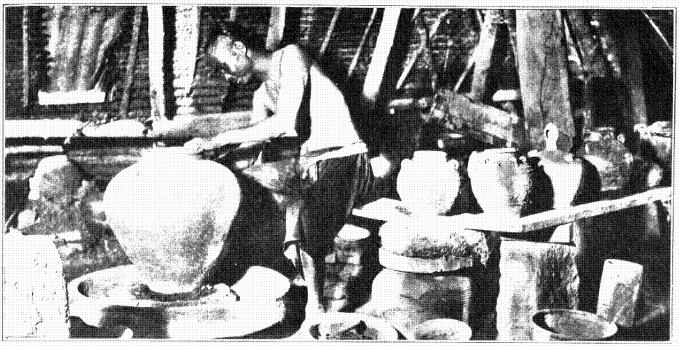


Fig. 1. Finishing a "tenaja."

Fig. 2. Beating pots into final shape.

Fig. 3. Native pottery market, Ilocos Sur.

PLATE LI. PHILIPPINE POTTERY.

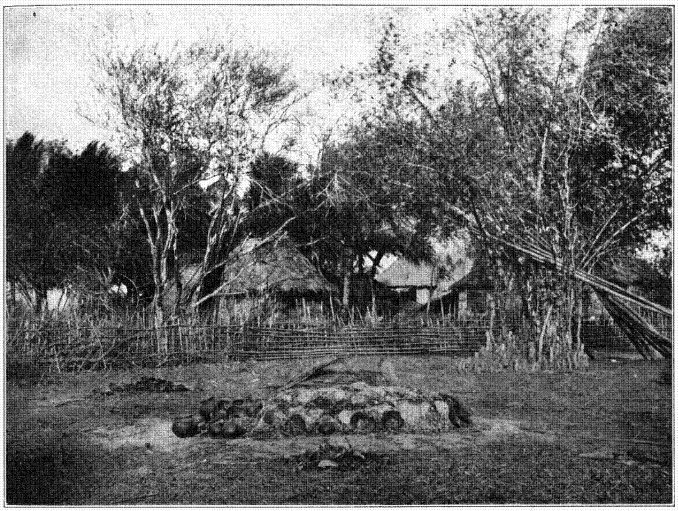


Fig. 1. Pile of pottery, showing method of burning.

Fig. 2. Glazed ware (made by first-year students).

PLATE LII.

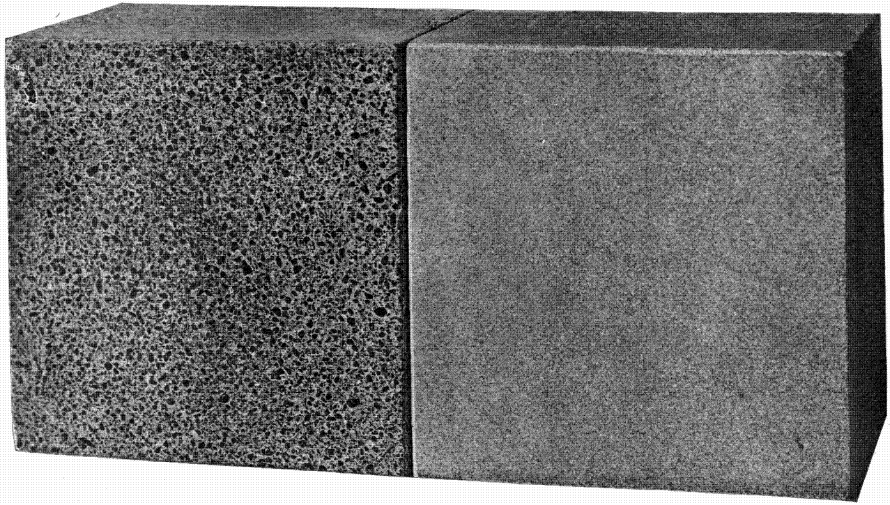


Fig. 1. Talim basalt quarry débris, brick mixture.

Fig. 2. Maytubig beach sand, brick mixture.

PLATE LIII. SAND-LIME BRICK AND ARTIFICIAL SANDSTONE.

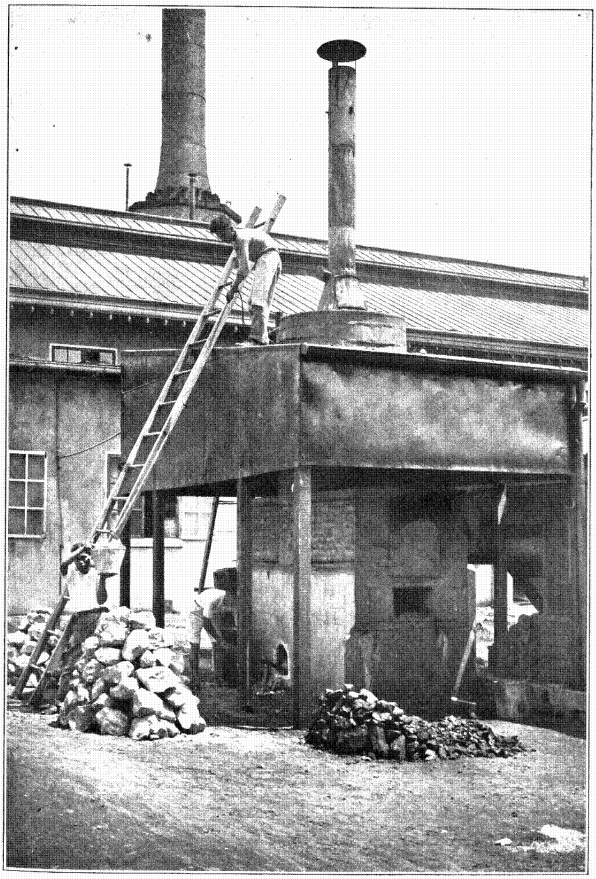


PLATE LIV. LIME KILN.

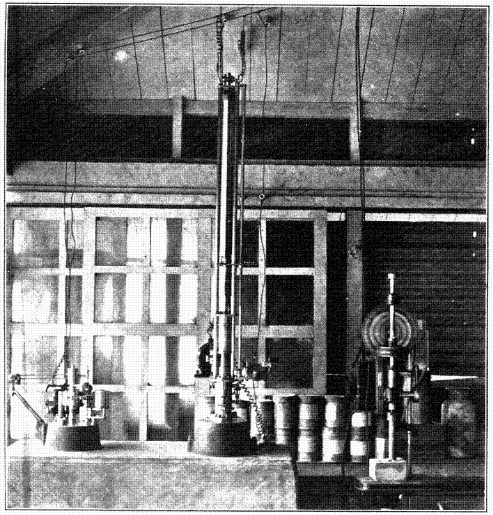


Fig. 1. Machines for testing road materials.

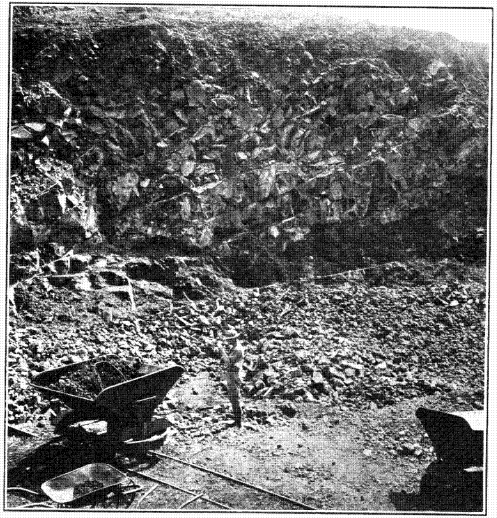


Fig. 2. Rizal Quarry Company's quarry, Rizal Province.

PLATE LV.

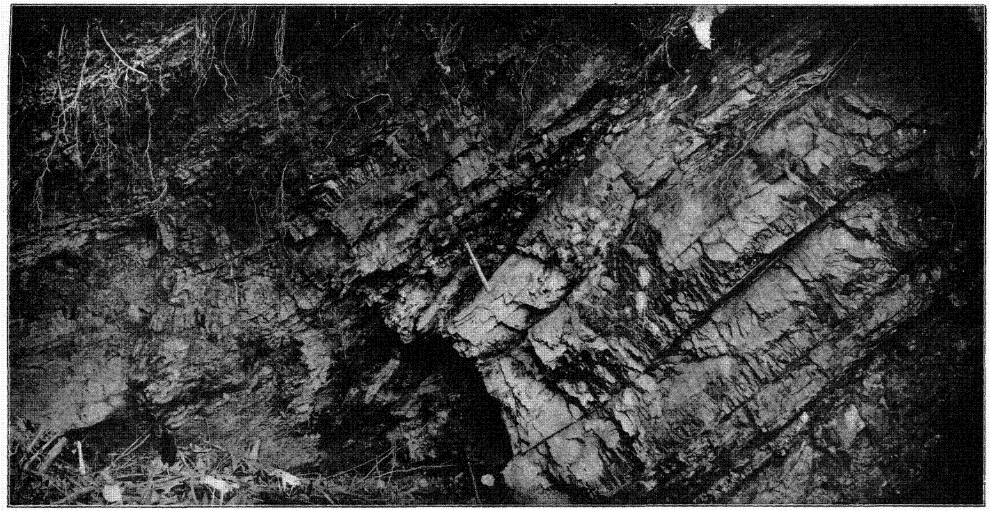


PLATE LVI. AN OUTCROP OF COAL, NACIPIT CREEK, ULING COAL FIELD, CEBU.

This seam is 4.75 meters thick, and dips to the west at an angle of about 40°.

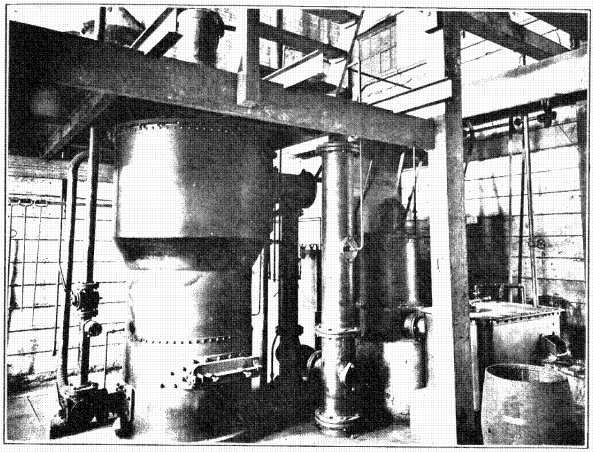


Fig. 1. Producer-gas plant.

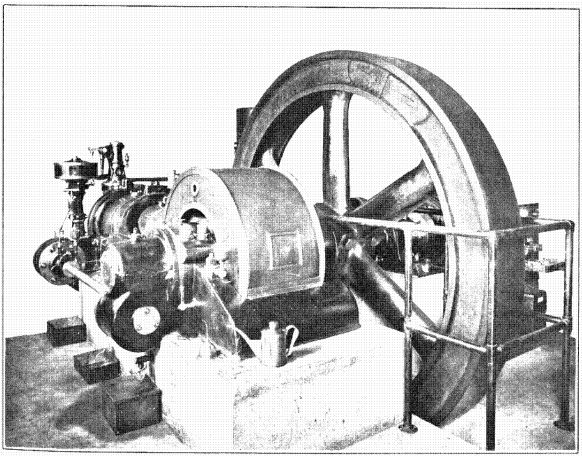


Fig. 2. Engine and dynamo direct coupled.

PLATE LVII.

Fig. 1. Bahay well 2, Bahay Valley Oil Company, Bahay, Mulanay, Tayabas.

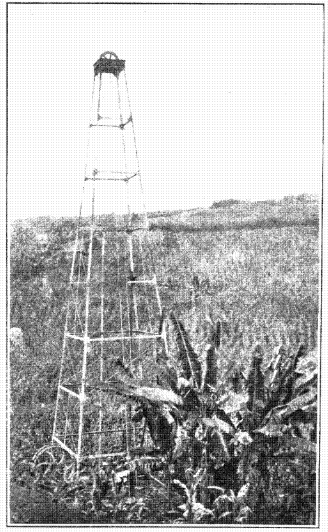


Fig. 2. Steel derrick over one of the wells drilled at Toledo, Cebu, in 1896.

PLATE LVIII.

their utility as a source of fuel or as a lubricant has been discussed. This oil is characterized by a comparatively high proportion of volatile hydrocarbons, a paraffin base, and by being free from sulphur.

71. *Ore deposits.*—The principles controlling the deposition of ores in the Philippines, the localization of pay streaks, the alteration and enrichment in calcite-quartz-manganese deposits, and the extent and probable depth of valuable deposits have been studied. The results of these investigations, particularly those which indicate the life of the mines, are of great practical value in mining operations.

72. *Baguio mineral district.*—A survey of this region has shown the distribution of the various formations and their relation to the topography of the country, mineral veins, types of ore bodies, water-power sites, transportation, timber, nonmetallic deposits, and various structural features such as roads, bridges, and buildings. Owing to the nature of the surface formations and the climatic conditions in the highlands of Luzon, there is an elaborate system of fracturing along complex systems of joints, and weathering extends to very great depths. Had this investigation been carried out sooner and the information been available before the construction of the Benguet Road, it would have been of great assistance; perhaps the road might not have been located where it is at present.

73. *Black sands.*—Studies of the black-sand concentrates, after careful cleaning at the dredges in placer districts, show that values remain which would several times pay for the cost of their shipment and treatment.

74. *Petrography.*—Our petrographic studies of several thousand rocks from all kinds of formations and from all parts of the Archipelago enable us to say how they are likely to behave under wear and stress and to indicate what rocks are suitable materials for road and other construction. By means of a petrographic microscope, it is possible to approximate the composition of a rock and for many purposes avoid a laborious chemical analysis. It is essential to know the kinds of rocks from which soils are derived in order to ascertain the potential plant food, and this can often be done by petrographic study. By this means we have discovered the existence of potash-bearing minerals in the rocks of Aroroy district of Masbate, where we had no previous knowledge of them. This information is of great importance to agricultural regions.

75. *Paleontology.*—In an accurate and reliable survey of economic deposits in sedimentary formations, particularly in coal

and oil fields, use must be made of information concerning the fossils, in the correlation of the strata. Our paleontologic studies have enabled us to correlate the coal and oil horizons of the Archipelago with similar deposits in Java, Borneo, Formosa, Sumatra, and other countries, and to deal intelligibly with facts which otherwise might have been obscure or unintelligible.

76. *Models.*—The Bureau of Science has a number of models of mines and mining appliances consisting of dredges, cyanide mills, blast furnaces, coal and metal mine models, etc. These are being constantly examined by students, prospectors, and laymen, and it is not unusual for such models to be made use of in litigations in explaining disputed points on technical questions.

77. *Engineering geology.*—Investigations have been carried on which clearly demonstrate that the correct interpretation in the location and design of many types of engineering projects is not only desirable but imperative, and the aid of an engineering geologist is often necessary when least expected. Our researches have explained discrepancies between astronomical and trigonometrical stations, and have referred them to the composition and specific gravity of mountain masses, after which the proper compensations and corrections were made.

78. *Physiographic studies.*—These investigations, which grow out of geologic studies, have great application in aiding ethnologists and historians in arriving at accurate and comprehensive conceptions of the factors which control the distribution of races and tribes and the development of their customs and in the correct interpretation of the past and future course of these factors. They should guide legislators in proposing laws and assist capitalists and executives in projecting large constructive economic projects, particularly in opening up new countries.

WORK OF THE FISCAL YEAR

The position of Director of the Bureau of Science, left vacant by the death of Dr. Paul C. Freer on April 17, 1912, has not yet been filled. The Assistant Director, who was appointed Acting Director on May 25, 1913, has continued to direct the affairs of the Bureau during the year.

Considerable attention has been given to the work of landscape gardening, general beautification of the lawns, and to the improvement of the grounds of the Bureau of Science. The dilapidated buildings in the rear have been repaired or removed, unsightly holes have been filled and irregular places leveled, and the hedges replanted. The Bureau of Public Works has overhauled the monkey house and the taxidermist's laboratory—

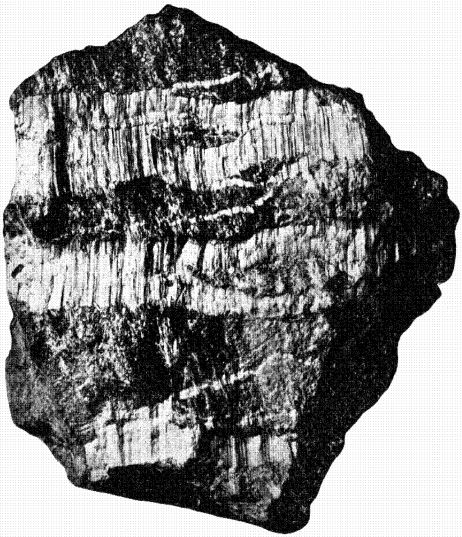


PLATE LIX. CRYSOTILE FROM DUNGU-DUNGAN, ILOCOS NORTE.

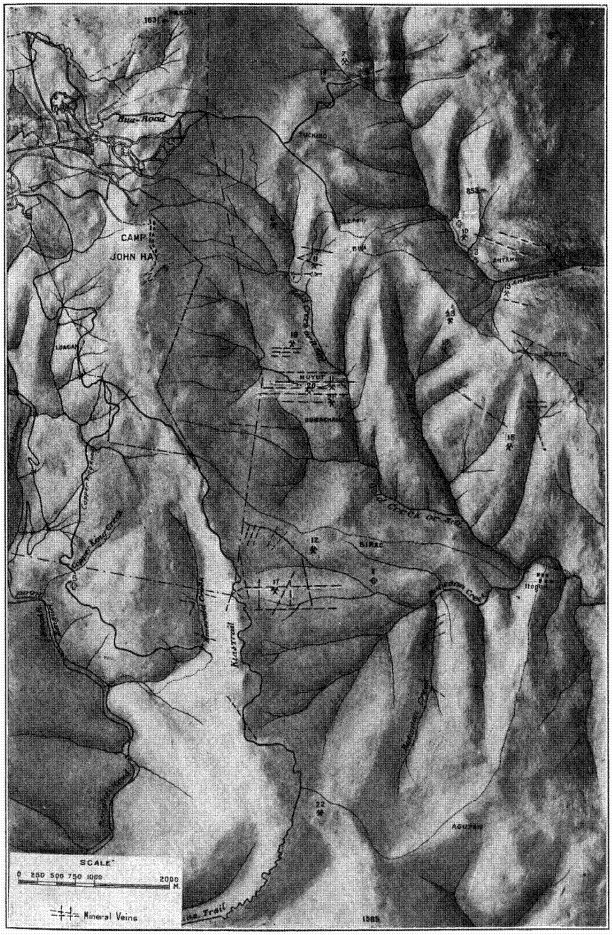


PLATE LX. MINERAL VEINS IN THE BAGUIO MINERAL DISTRICT.

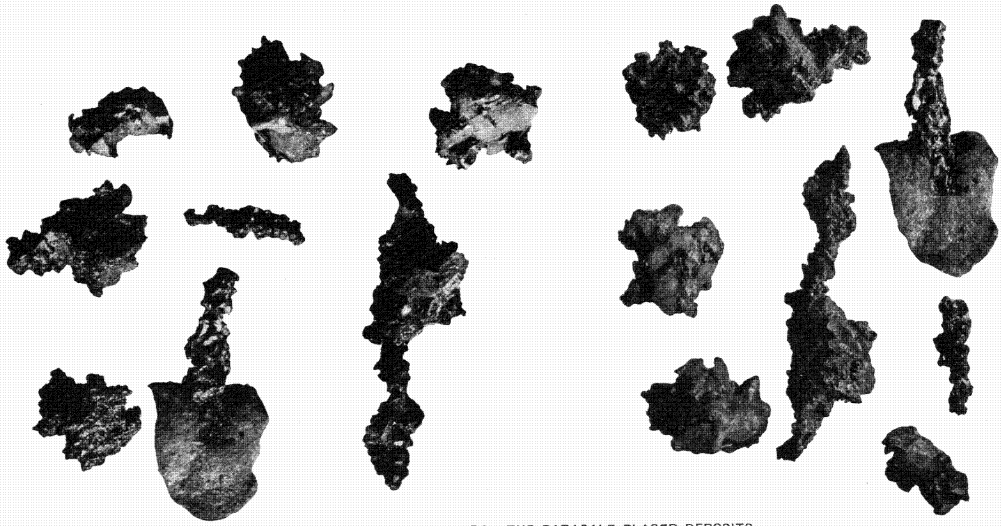
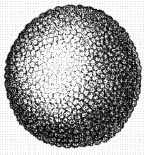
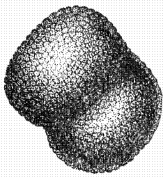


PLATE LXI. GOLD NUGGETS FROM THE PARACALE PLACER DEPOSITS.



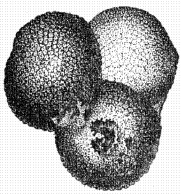
1



2

4

5



3

PLATE LXII. GLOBIGERINA, A POSSIBLE SOURCE OF OIL IN TAYABAS.

two of the outbuildings in the rear of the east wing of the main laboratory building—and has provided each with a new cement floor which greatly improves their appearance and usefulness. The tar pits in the rear of the power house have been encased in cement, and a storm drain connecting with the storm sewer on Taft Avenue has been laid to drain the rear of the premises and to receive the water pumped from the tunnel. The filling of the swamp at the corner of Calle Herran and Taft Avenue, next to the east wing, has been completed to a sunken garden grade and will soon be planted to lawn.

The following figures show that the amount of routine work in practically all divisions and sections of the Bureau has increased greatly, and would have seriously interfered with our research work except for the devotion of our scientists who have worked in the afternoons during the hot season, after hours on week days, and on Saturday afternoons and holidays. In view of the great difference in the relative value and necessity of research as compared with most routine work, I regret that our employees have been occupied so largely with the latter, especially as many requests for routine work are founded on a false impression of the value of the specified test. For example, the presence or absence of amœbæ in surface water is being regarded of less and less sanitary significance. The organisms which live in surface water are incapable of living as parasites in the intestines of man, and consequently are not concerned in the production of dysentery. There is no doubt as to the distinction between the pathogenic and the nonpathogenic amœbæ. It follows that the mere presence or absence of amœbæ has little sanitary significance, and the examination should be omitted where practicable. Often the ability of a cement to pass the requirements of specifications does not prove either its actual or relative value; the purity of a paint does not fix its value as a protective coating; the percentage of chlorine does not establish the potability of water; and the bacteria count of a water several hours in transit to the laboratory, unless packed on ice, has no value. We are requested to make chemical analyses of samples and from the results obtained make definite statements concerning such complicated considerations as the rapid corrosion of a piece of galvanized iron, the relative suitability of paints for use in sea water, the value of a mineral paint, of creosote oil, or of tars, asphalts, and bitumens for paving purposes, of Babbitt metals, of lubricating oils, etc. Obviously, it is often impossible to give such information, and inability to do so is sometimes considered as incompetency. My endeavor to dis-

courage requests for analyses and examinations of doubtful value has not always been successful.

In spite of the difficulties, a large amount of research has been carried on in the Bureau of Science and the results published. The titles of all articles published by members of the Bureau of Science during the year are given in one place under the heading of The Philippine Journal of Science and other publications. Changes in the personnel are given under the discussion of that division of the Bureau in which the individual worker was employed. Other than this the names of individuals have been omitted so far as possible. A list of the scientific staff is given on the second page of the cover.

FAR EASTERN ASSOCIATION OF TROPICAL MEDICINE

The first biennial meeting of the Far Eastern Association of Tropical Medicine was held in Manila between the dates of March 5 and 14, 1910. The second congress of this association was held in Hongkong on January 27, 1912. Both of these sessions were well attended, and the papers which were read treated of a great variety of subjects and stimulated much interesting discussion. Many of the papers of the association have been published in The Philippine Journal of Science. These meetings demonstrated conclusively the great benefit to the Orient which can be derived from an organization of this kind, and the subjects discussed are of the greatest interest and importance to the Philippine Islands. The third congress of the association will be held in Saigon from November 8 to 15, 1913, and Dr. E. L. Walker of this Bureau has been appointed by His Excellency, the Governor-General, as one of the delegates from the Philippine Islands.

BIOLOGICAL LABORATORY

Personnel.—Dr. R. P. Strong, chief of the biological laboratory of the Bureau of Science, who went on leave on account of illness in July, has resigned to accept a position as chief of the department of tropical medicine in Harvard University Medical School. Dr. B. C. Crowell, pathologist in this laboratory, has been detailed for one-half of his time as chief of the department of pathology and bacteriology in the College of Medicine and Surgery of the University of the Philippines. Mr. Ariston M. Guzman left Manila on leave for the Bennett Medical College, Chicago, on May 16, 1913, where he has registered for medical work. The resignation of Mr. Porter Leaky was accepted April 15, 1913. Dr. John A. Johnston, from the laboratory of hygiene, University of Pennsylvania, was appointed

assistant in the biological laboratory, and assumed his duties November 11, 1912. Mr. Lyle D. McMillan was transferred from the Bureau of Education to the biological laboratory of this Bureau June 5, 1913. Three assistants in the routine laboratory have left during the year and have been replaced by other men. The position of chief of the biological laboratory and a few other vacancies remain unfilled.

All of the instruction in medical zoölogy in the College of Medicine and Surgery and in the Graduate School of Tropical Medicine and Public Health of the University of the Philippines is given by members of the staff of the biological laboratory of the Bureau of Science. The courses given in the undergraduate school of medicine include—

1. A course in protozoölogy, occupying 3 hours a week during the second semester.
2. A course in helminthology, occupying 9 hours a week during the first semester.
3. A course in medical entomology, occupying 2 hours a week during the first semester.

In the Graduate School of Tropical Medicine and Public Health, the courses in protozoölogy and helminthology will occupy in the class room and laboratory at least 12 hours a week throughout the year, and the course in medical entomology at least 24 hours a week for six weeks, exclusive of the preparation of lectures and of material for laboratory work which requires at least as much more time.

ROUTINE WORK

The routine work is constantly increasing and occupies more and more of the available staff of this laboratory. It showed an increase in 1912 of 45 per cent above that of the year before, and there has been a still greater increase during the past year, as shown by the table on page 46. Branch laboratories are still maintained at the Philippine General Hospital and at Bilibid Prison Hospital to handle the large amount of clinical laboratory work at these institutions. An assistant from the laboratory has been detailed to make bacteriological examinations on each trip of the Bureau of Health to collect lepers.

The following table shows the number of routine examinations made during the past, and, for comparison, during the preceding fiscal year. The classification of these examinations for the year of 1912 was less exact, many of the samples classified in this table being put under miscellaneous. This accounts for the blank spaces in the 1912 column.

Nature of examination.	1912	1913
Blood	3,951	23,450
Blood culture	----------	226
Widal test	----------	388
Wassermann test	----------	727
Urine	----------	6,974
Sputum	3,925	5,770
Fæces	22,733	34,530
Gonococci	15,971	20,522
Leprosy	----------	848
Plague	----------	45
Rats for plague	----------	(a)
Rabies	----------	11
Autopsy	59	130
Histological examination	455	606
Water	742	1,077
Miscellaneous	4,594	57,916
Total	51,941	153,220

[a] Included under miscellaneous.

In many cases the requests accompanying these samples were for more than one kind of examination; as, for example, red corpuscle count, total and differential white corpuscle count, hæmoglobin determination, and malarial parasites in one sample of blood; or, *Trichuris, Ascaris, Ankylostoma,* monads, amœbæ, *Strongyloides, Oxyuris, Tænia, Opisthorchis, Balantidium,* blood cells, mucus, and pus in one sample of fæces. Therefore, the table does not indicate the total number of examinations made, but only the number of requests received.

INVESTIGATIONS

On account of the vacancies in the staff and the constantly increasing amount of routine work in the laboratory, it has been necessary repeatedly to take men from research work to help with the routine work or to send into the field to make special investigations. This has in many cases seriously interfered with the research work that was being conducted.

Plague.—In the course of the plague outbreak during the past year, some investigations were made on the diagnosis, transmission, and pathology of bubonic plague. The importance of blood culture and the uselessness of the agglutination test in the diagnosis of plague, the part played by phagocytosis in the resistance of man to plague infection, and the presence of numerous plague bacilli in comparatively insignificant skin lesions which indicate the possibility of direct infections with bubonic plague have been demonstrated. The rôle of rat fleas

in the transmission of bubonic plague has received further confirmation from the study of an outbreak of plague among guinea pigs in the animal house, in which transmission by rat fleas was demonstrated and in which all other methods of transmission were excluded. The finding of a naturally infected plague cat confirms the belief that these animals might be a source of infection to man in plague epidemics. An extended pathological study of the lesion of bubonic plague, as found in the human cases during this outbreak, is now in progress by the pathologist of this laboratory.

Cholera.—A new and quicker procedure in the isolation and identification of the vibrio of Asiatic cholera has been devised, but owing to the absence of cases of this disease in the Philippines the work is unfinished. The method depends on the separation of cholera vibrios from other bacteria by the use of agglutinating serums in pipettes and by making use of the positive chemiotaxis of cholera vibrios in the presence of certain substances. The importance of the earliest possible diagnosis of cholera in preventing the spread of the disease is recognized, and this new method promises to be of material aid to this end.

Bacillary dysentery.—A study has been made of morphological and biological variations in strains of *Bacillus dysenteriæ,* isolated by the single-cell method. Several strains have been isolated which showed morphological variations and differences in their capacity to ferment carbohydrates, and certain of these varieties have been found to be constant. This work has a practical bearing on the diagnosis of dysentery. An investigation of the bacteriology of infantile diarrhœas is now in progress.

Infection studies with the bacteria of cholera, dysentery, and plague and with *Bacillus pyocyaneus* and *Aspergillus* injected into the cells of the mold *Achlya* have been carried on. They included principally a study of the permeability of the walls of the plant for agglutinins and acids with the treatment of infections by these substances.

Tuberculosis.—A study of tuberculosis infection in animals has demonstrated the greater resistance of guinea pigs to infection with bacilli from human sources under conditions obtaining here than in temperate climates, and an attempt to immunize guinea pigs with virulent cultures of tuberculosis has resulted negatively. Also, a study of the occurrence of tuberculosis associated with leprosy and the investigation of a strain of tubercle bacilli from a leprous patient which has produced a

remarkable enlargement of the spleen of infected guinea pigs have been carried on.

Leprosy.—A study is being made of the organisms cultivable from leprous tissues, with especial reference to classifying the organisms cultivated from such sources by different authors and to determining the etiologic relationship of such organisms to leprosy.

Entamœbic dysentery.—The investigation of entamœbic dysentery, which has extended over a period of nearly three years, has been completed and will be published in six parts, occupying the whole of No. 4, Section B, The Philippine Journal of Science, of the current year under the title Experimental entamœbic dysentery.

Part I. Introduction.
Part II. Feeding experiments with cultures of amœbæ.
Part III. Feeding experiments with *Entamœba coli.*
Part IV. Feeding experiments with "*Entamœba tetragena*" and *Entamœba histolytica.*
Part V. Applications of the results to the diagnosis, treatment, and prophylaxis of entamœbic dysentery.
Part VI. Summary and conclusion.

Balantidiasis.—As indicated on page 20 little is known about the epidemiology of balantidiasis. The infection presents the following problems which are under investigation:

1. The frequency of human infections with *Balantidium coli* in the Philippine Islands.
2. The presence of the parasite in the domesticated pig in the Philippines.
3. The question of the identity of the balantidium of the pig and of man.
4. The part played by the pig in the dissemination of the infection to man.
5. The experimental infection of animals.
6. The ability of *Balantidium coli* to penetrate the sound intestinal epithelium.
7. The pathogenesis of *Balantidium coli.*
8. The cause and nature of the latent infections with this parasite.
9. The early, preulcerative, pathology of balantidiasis.
10. The treatment of balantidiasis.

The results of a portion of this work have been published in The Philippine Journal of Science. Investigations are now in progress which promise to throw much light upon the other problems presented by this parasitic disease.

Malaria.—In January of the present year a joint commission of representatives from the Bureau of Science, the Bureau of Health, and the College of Medicine and Surgery of the University of the Philippines made a sanitary survey of the San José estate and adjacent properties in Mindoro, with special

reference to malaria. The part taken by the Bureau of Science in this investigation includes:

1. A topographical survey with maps of the region.
2. An entomological survey, with especial reference to the habits and breeding places of flies and mosquitoes capable of transmitting malaria.
3. The collection and microscopic examination of blood smears for malarial parasites from 1,098 persons.
4. The examination of a limited number of stool specimens to determine the intestinal parasite index.
5. A study of the comparative value of the "spleen index" and of microscopic examination of the blood in the diagnosis of malaria.

The results of the investigation of this commission, which will supply an important contribution to the epidemiology of malaria and to the prophylaxis of the disease as it exists in the Philippine Islands, will appear in an early number of Section B of The Philippine Journal of Science.

Surra.—An investigation of the therapeutic action of certain drugs and chemicals upon surra has been undertaken, but is at present suspended awaiting the arrival of chemicals from abroad.

Helminthology.—The essential facts of the life history of the worm (*Œsophagostomum apiostomum*) of the nodular intestinal disease, which is a frequent parasite of apes and occasionally of man, have been worked out, and experiments are in progress to determine the methods of infection with this parasite. It is probable that the larva is capable of penetrating the skin of man as is the case of the larva of the hookworm.

The domesticated pig as a "carrier" of infections.—It is already known that the pig is a source of infection to man in the case of the pork tapeworm (*Tænia solium*) and the muscle worm (*Trichinella spiralis*), but no definite knowledge is had of the rôle it plays in the spread of other diseases and parasites. The fact that domesticated pigs commonly live near or under the houses of Filipinos and the part the pig plays as a scavenger in the Philippine Islands have led us to investigate the possibility of these animals becoming infected with, and acting as "carriers" of, intestinal diseases and parasites communicable to man. The present investigation included a determination of the intestinal parasites occurring naturally in the pig, and experiments with bacillary dysentery, cholera, entamœbic dysentery, and balantidiasis, and with the hookworm and other intestinal worms. The results of these experiments have led to the conclusions that the domesticated pig cannot be infected with, and consequently plays no rôle in the dissemination of, cholera, bacillary dysentery, entamœbic dysentery, or hookworm

infections, but that this animal is the chief source of infection of man with *Balantidium coli* and, probably, also with *Strongyloides stercoralis.*

Outbreak of disease in Ambos Camarines.—In October an expedition was made to Buhi, Ambos Camarines, to study an unusual epidemic disease reported by a local health officer. Several fatal cases had occurred previous to the expedition, and about 18 cases of a peculiar inflammatory disease said to be the same as that causing earlier fatal cases were found. These cases were studied clinically, and microscopical examinations and animal inoculations were made. Plague and anthrax were excluded. The positive findings were few, except that pyogenic organisms were demonstrated in the lesions. The disease may be a remarkable type of pyogenic infection or possibly pyogenic bacteria may simply accompany this disease of unknown cause.

Artesian wells.—Bacteriological examinations of 35 artesian wells in the Provinces of Bulacan, Rizal, and Cavite, with the object of determining if any are subject to pollution, resulted in the discovery that all flowing wells have water of extraordinary bacterial purity, approaching, if not attaining, sterility in most cases. The nonflowing wells examined also show low bacterial count and no signs of pollution except in the well at Bocaue, where there is strong evidence of pollution.

Sickness at Cabanatuan.—Unfinished investigation of enteritis, with personal experience with the disease, occurring on a hacienda near Cabanatuan, Nueva Ecija, indicates toxins of bacterial origin occurring in the milk of a certain cow as the cause. Dysentery, mineral poison occurring in the well, or ptomaines other than those formed in milk or cream seem well excluded.

Locust-exterminating bacterium.—*Coccobacillus acridiorum* d'Herelle, of which a culture was obtained from Argentine Republic by the Honorable, the Secretary of the Interior, has been used in a series of inoculation tests and in ingestion experiments on locusts—in pens in the laboratory and in swarms in the open field—in nearly all stages of development and under various conditions of weather. The practical results have been negative. In the very few partially positive field experiments the percentage of insects that died was small and there seemed no tendency for the infection to spread in the swarm. If this infection has succeeded elsewhere, its failure here may be due (1) to meteorologic conditions or (2) to a difference in the species of locust. Mr. C. R. Jones of the Bureau of Agriculture coöperated with us in this work.

Pathology.—In addition to the pathological study of bubonic plague mentioned under that head, pathological investigations have been made of status lymphaticus among Filipinos, of intestinal parasites in 500 autopsies, and pathological examinations of material from the surgical clinic of the Philippine General Hospital. Six hundred six histological examinations of surgical pathology specimens were made in connection with the latter work, of which a detailed analysis for once is here given.

	Cases.
Abortion	4
Adenoma	6
Thyroid	5
Uterus	1
Adenocystoma	16
Thyroid	11
Ovary	5
Adenofibroma	4
Breast	4
Adenomyoma	2
Uterus	2
Adenomyxoma	1
Neck	1
Appendix	269
Normal	10
Incidental removal	52
Appendicitis—	
Acute	61
Chronic	130
Subacute	13
Tuberculous	3
Axilla	1
Cyst, Teratoma	1
Back	1
Probable tuberculous abscess	1
Bone	1
Osteomyelitis	1
Bursa	2
Bursitis—	
Chronic, elbow	1
Tuberculous, hip	1
Broad ligament	1
Abscess	1
Calculi	38
Vesical	37
Renal	1
Carcinoma. (*See* Intestine, Liver, Lymphatic glands, Mammary gland, Nose, Ovary, Parotid gland, Thyroid, Uterus.)	

	Cases.
Cervix uteri	46
Amputations and repairs for lacerations, cervicitis, and hypertrophies	39
Malignant adenoma	1
Epithelioma	4
Polyps (fibromyoma)	2
Curettings, uterine	44
Cysts—	
Bartholini's gland. (*See* Vulva.)	
Dermoid. (*See* Axilla, Ovary, Vulva.)	
Fallopian tube. (*See* Fallopian tube, Hydrosalpinx.)	
Ovarian. (*See* Ovary, Cysts.)	
Parovarian. (*See* Parovarium, Cysts.)	
Sebaceous. (*See* Skin, Sebaceous cysts.)	
Thyroid. (*See* Thyroid, Cysts.)	
Tuberculous	2
Thigh	1
Shoulder	1
Ear	2
Epithelioma, papillary	2
Endothelioma. (*See* Meninges, Parotid gland and Submaxillary gland tumors, and Skin.)	
Epididymis	4
Epididymo-orchitis—	
Tuberculous	3
Chronic	1
Epithelioma. (*See* Skin, epithelioma; Cervix uteri, epithelioma; Tonsils, epithelioma; Neck, tumors; Ear, epithelioma; Nose, polyp.)	

	Cases.		Cases.
Eye	5	Lachrymal gland	1
Hypopyon	1	Andenitis, chronic	1
Sarcoma	2	Leg	1
Panophthalmia	1	Sarcoma, spindle-celled	1
Glioma retina	1	Leprosy	1
Fallopian tubes	33	Skin	1
Hydrosalpinx	2	Lipoma	3
Hæmatosalpinx	2	Forehead	1
Perisalpingitis, chronic	7	Back	1
Salpingitis—		Leg (4,470 grams)	1
Acute suppurative	2	Liver	3
Chronic	16	Syphilis	1
Tuberculous	2	Carcinoma	1
Tubal gestation	2	Abscess	1
Finger	2	Lympathic glands	52
Supernumerary thumb	1	Carcinoma—	
Corn on thumb	1	Secondary	9
Gall bladder	4	Axillary, metastatic from breast	7
Cholelithiasis	3	Cervical metastatic from thyroid	1
Cholecystitis, chronic	1	Mesenteric metastatic from (?)	1
Granuloma	4	Lymphadenitis—	
Ulcerative granuloma pudendi	2	Acute	3
Leg, undetermined	1	Suppurative, cervical	1
Foot, undetermined	1	Syphilis, inguinal	1
(*See* Leprosy, Syphilis, Tuberculosis.)		Hyperplastic, axillary	1
Gum	2	Lymphadenitis—	
Epulis, fibroma	1	Chronic	3
Dentigerous cyst	1	Femoral	1
Hæmangioma	4	Mesenteric	1
Intraocular	1	Submaxillary	1
Submaxillary region	1	Sarcoma	5
Intramuscular	1	Abdominal	1
Cheek	1	Axillary, secondary	1
Hæmangiofibroma	2	Cervical, secondary	2
Palm of hand	1	Mesenteric, secondary	1
Lower lip	1	Tuberculosis	31
Intestine	6	Axillary	3
Carcinoma, scirrhous	1	Cervical	23
Gangrene, strangulated hernia	1	Femoral	1
Lymphosarcoma	1	Mesenteric	3
Tuberculosis (cæcum)	2	Submental	1
Foodstuff from enema	1	Syphilis	1
Joints	1	Femoral	1
Arthritis, chronic, elbow	1		
Kidney	1		
Nephrolithiasis	1		

	Cases.
Mammary gland	15
Adenofibroma	4
Carcinoma	11
Meninges	1
Endothelioma, dura mater	1
Mesentery	1
Cyst	1
Neck	7
Adenomyxoma	1
Epithelioma	1
Branchiogenic	2
Mucocele (?)	1
Sarcoma, round-celled	1
Sebaceous cysts	1
Nerves	3
Neurofibroma	3
Nose	6
Papillary carcinoma	1
Nasal—	
Polypus	4
Carcinoma	1
Omentum	1
Fibrosarcoma, secondary	1
Ovary	57
Abscess	1
Carcinoma	2
Cyst, dermoid	2
Cystadenoma, papillary	5
Cystoma—	
Multilocular	11
Simple	9
Oöphoritis—	
Acute	3
Chronic	19
Tuberculous	2
Teratoma	2
Fibroma with hæmorrhage	1
Papilloma. (*See* Skin, papilloma; Vulva, papilloma.)	
Parotid gland	7
Carcinoma	2
Mixed tumors	4
Endothelioma	1
Parovarium	11
Cysts	11
Prostate gland	1
Prostatitis, chronic hyperplastic	1

	Cases.
Sarcoma. (*See* Lymphatic glands, Intestine, Leg, Skin, Testis.)	
Skin	46
Adenocarcinoma originating from mucous gland	1
Corns	2
Epithelioma	12
Fibroma	3
Granuloma	4
Hæmangiofibroma	2
Leprosy	1
Nævus	1
Papilloma	3
Sarcoma	8
Sebaceous cyst	5
Syphilis	2
Tuberculosis	2
Spleen	1
Splenomegaly, endothelial hyperplasis in splenic anæmia	1
Submaxillary gland	2
Mixed tumors	2
Syphilis	3
Lymphatic gland	1
Skin	2
Tendon	6
Tenosynovitis—	
Chronic	5
Tuberculous	1
Testis	6
Tuberculosis	5
Sarcoma	1
Thyroid	44
Adenoma	5
Carcinoma	8
Colloid goitre	16
Cystadenoma	11
Cysts, simple	4
Tonsil	3
Epithelioma	2
Tonsillitis, chronic	1
Tongue	2
Carcinoma	2
Tuberculosis. (*See* Epididymis, Fallopian tubes, Lymphatic glands, Ovary, Skin, Testis, Uterus, Vas deferens.)	

	Cases.
Tunics of testis	3
Hydrocele	3
Urethra	2
Polyp	2
Uterus	34
Adenomyoma	2
Carcinoma fundus	1
Epithelioma cervix	1
Fibromyoma largest, 15.5 kilograms	15
Hydatid mole	1
Hydrometrium from adenoma cervix	1
Lipomyoma	1
Metritis	4
Malignant adenoma cervix	1

	Cases.
Uterus—Continued.	
Myoma	5
Tuberculosis	2
(*See* Cervix uteri, Curettings, uterine.)	
Vas deferens	1
Tuberculosis	1
Vulva	4
Cyst—	
Dermoid	1
Bartholini gland	1
Epithelioma	1
Papilloma	1

Immunity.—The study of the duration of passive immunity against tetanus toxin has been continued, and the following conclusions reached:

1. The subcutaneous injection of 1,500 units of antitetanic serum from horse into horse confers passive immunity of between six and eight weeks' duration.
2. Guinea pigs subjected to repeated inoculations with antitetanic serum from horse do not acquire the power to eliminate it more rapidly; they acquire a tolerance as is shown by the longer period of immunity.
3. After repeated injections of normal horse serum into guinea pigs, passive immunity, following the injections of antitetanic serum from horse, is of longer duration than it is in untreated guinea pigs.

A comparison of the different modifications of the Wassermann test for syphilis has been made for the purpose of determining their relative value and reliability. In confirmation of the results of other investigators, methods in which unheated serum is used give a much higher percentage of positive results than those in which heated serum is used.

Serums and vaccines.—The preparation of variola vaccine (vaccine virus) was continued throughout the year. Cholera prophylactic, plague prophylactic, gonococcus vaccine, staphylococcus vaccine, typhoid vaccine, and streptococcus vaccine were prepared in moderate quantities. Anthrax vaccine, tuberculin (both human and bovine), and mallein were continually kept on hand.

Antidiphtheritic, antitetanic, anticholera, antityphoid, antiplague, antidysenteric, and antistreptococcic sera were made in quantities sufficient to supply the demand.

Typhoid, paratyphoid, and cholera reagents (killed cultures) for agglutination; agglutinating sera, in liquid and in dried form, for the purpose of diagnosing infectious diseases and identifying bacteria; as well as normal sera of horse, ox, sheep, and goat were always kept on hand. Other sera, such as those of dog, cat, rabbit, and guinea pig, are supplied on request. Sterile blood or washed blood corpuscles of horse, ox, sheep, goat, rabbit, and guinea pig are also furnished on request.

Rabies.—The work on rabies was continued throughout the year. Thirty-six patients applied for the Pasteur treatment during the year.

BOTANICAL SECTION OF THE BIOLOGICAL LABORATORY

Personnel.—Mr. E. D. Merrill, chief of this section, was detailed in July, 1912, for one-half of his time to duty in the University of the Philippines as acting head of the department of botany, College of Liberal Arts, with the title of associate professor of botany. The chief objection to the plan is that it has decreased the time available for research work. Dr. C. B. Robinson, formerly economic botanist, who resigned August 18, 1911, was reinstated, reporting for duty November 15, 1912, which partially compensates for the loss of time for research by Mr. Merrill. At this time the positions provided for in the botanical staff being all filled, Doctor Robinson's appointment was made possible by arrangement with the University of the Philippines, by which the Bureau of Science undertook to provide, by detail, an assistant in botany for the College of Liberal Arts. Mr. P. W. Graff, mycologist, was detailed to give the necessary assistance in the classes in botany, acting as assistant in two laboratory courses.

The herbarium.—The growth of the herbarium has been eminently satisfactory, but the following summary does not include about 1,100 numbers secured in Palawan. A total of 12,807 specimens have been poisoned, mounted, and added in the past year from the following sources:

Collections of employees of the Bureau of Science	5,066
Collections of employees of the Bureau of Forestry	1,065
Miscellaneous Philippine material, received by gift, by purchase, and for identification	2,799
Extra-Philippine material received in exchange and by gift	3,877
Total	12,807

Of the miscellaneous Philippine collections mentioned above, specimens were received from the following sources:

Father M. Vanoverbergh, Lepanto and Bontoc plants for identification	383
Father F. Sanchez, Benguet plants for identification	24
A. D. E. Elmer, purchased	512
Federico R. Bona, Lepanto plants for identification	153
E. D. Merrill, Century XII Philippine Plants	100
C. F. Baker, flowering plants (for identification) and fungi (presented)	653
F. C. Gates, for identification, chiefly from Laguna Province	798
O. F. Sevrens, Benguet plants for identification	81
J. P. Eskridge, Negros plants for identification	57
Miscellaneous	38
Total	2,799

The extra-Philippine material received in exchange has proved to be especially valuable. The most valuable exchanges, for our purposes, have been those received from the Botanic Garden at Edinburgh, Scotland, and from the Botanic Garden at Buitenzorg, Java, the former institution sending plants from India and from China, the latter plants from Java. Following is a summary of the extra-Philippine material:

S. F. Light, Manila, Japanese plants, presented	25	
National Herbarium, Melbourne, Victoria, Australian plants, exchange	50	
H. Winkler, Breslau, Germany, Bornean plants, exchange	106	
C. G. Lloyd, Cincinnati, Ohio, American and European fungi	24	
H. H. Travers, New Zealand plants from Prince Roland Bonaparte, exchange	100	
E. J. Butler, Pusa, India, Indian fungi, exchange	100	
J. Kneucker, Karlsruhe, Germany, Glumaceae exsiccatae	274	
Carnegie Museum, Pittsburgh, Pa., O. E. Jennings, Isle of Pines plants, exchange	126	
Mauritius Forestry Department, Mauritius plants, exchange	76	
Field Museum of Natural History, Chicago, Ill., tropical American plants, exchange	102	
Rev. C. King, Ambasi, Papua, New Guinea plants, exchange	119	
Royal Botanic Garden, Kew, England, fungi, exchange	59	
Botanical Institute, Imperial University, Tokyo, Japan, Liu Kiu plants, exchange	238	
United States National Herbarium, Palmer and Riley, Cuban plants, exchange	140	
H. Yanagawa, Koshun, Formosa, Formosan plants, exchange	121	
Buitenzorg Botanical Garden, Javan plants, exchange	530	
		2,190

Royal Botanic Gardens, Edinburgh, Scotland:		
E. E. Maire, Yun-nan-sen, China	612	
J. M. Dalziel, China	43	
Walker-Arnott, India	33	
Wight, India	191	
Walker, Ceylon	166	
J. C. Prazer, Burma	104	
Miscellaneous	163	
		1,312
H. and P. Sydow, Berlin, Germany:		
Phycomyceten and Protomyceten	25	
Uredineen	300	
Fungi exotici exsiccati	50	
		375
Total		3,877

A large collection of plants, some 800 in number, made by Mrs. M. S. Clemens in the Provinces of Shantung and Chihli, China, has not been recorded as no opportunity has been had to arrange the material in sets for identification and distribution.

The total number of specimens now in the herbarium is 119,386, of which about 75,500 are Philippine.

Loans and distribution of duplicates.—Comparatively few requests have been received for loans of mounted material, the following being the summary of sheets loaned during the year:

Philippine Lycopodium to Dr. W. Herter, Porto Alegre, Brazil, for an enumeration of the Philippine forms	222
Nepenthes to Dr. J. M. Macfarlane, University of Pennsylvania	5
Cissus to Dr. H. Hallier, Leiden, Holland, for critical comparisons with Blume's Javan types	36
Sporobolus to F. T. Hubbard, Cambridge, Mass	40
Derris to S. T. Dunn, Kew, England, for a monograph of the genus	20
Grewia to J. R. Drummond, Kew, England	6
Orchidaceae to Oakes Ames, North Easton, Mass., for identification and critical study	334
Total	663

The following material has been sent to the specialists indicated for monographic purposes or for purposes of identification:

Ferns to Dr. E. B. Copeland, Los Baños, Luzon	216
Mosses to Dr. V. F. Brotherus, Helsingfors, Finland	242
Lichens to Dr. E. A. Wainio, Helsingfors, Finland	97
Fungi to Dr. H. Sydow, Berlin, Germany	797
Piperaceae to C. DeCandolle, Geneva, Switzerland	86
Nepenthes to Dr. J. M. Macfarlane, Philadelphia, Pa	14
Gesneriaceae to Dr. Fr. Kränzlin, Berlin, Germany	12

Araceae to Dr. A. Engler, Berlin, Germany	27
Selaginella to Dr. G. Hieronymus, Berlin, Germany	65
Dioscorea to I. H. Burkill, Singapore	9
Bambusae to J. S. Gamble, East Liss, England	10
Asclepiadaceae to Dr. R. Schlechter, Berlin, Germany	56
Pandanaceae to Dr. U. Martelli, Florence, Italy	26
Palmae to Dr. O. Beccari, Florence, Italy	33
Lycopodium to Dr. W. Herter, Porto Alegre, Brazil	11
Cyperaceae to Rev. G. Kükenthal, Coburg, Germany	64
Menispermaceae and Anonaceae to Dr. L. Diels, Marburg, Germany	100
Symplocos to Dr. A. Brand, Sorau, Germany	8
Capparidaceae, Urticaceae, etc. to Dr. Hallier, Leiden, Holland	174
Total	2,047

In the course of the year somewhat over 10,000 identifications have been made, for the most part Philippine plants but including also material from Guam, New Guinea, Java, Formosa, and Borneo. Most of the specimens identified have been deposited in the herbarium, but a great number of additional plants, not preserved, have been identified for the Bureau of Education, of Forestry, and of Agriculture. Several hundred specimens belonging to the herbarium of the College of Agriculture at Los Baños also have been identified.

A determined effort was made to complete the labels and distribute our accumulated duplicates into sets for distribution, as no large distribution of duplicates was made in the preceding year. This work was accomplished, and the work of distribution practically twice that of the former year was completed by April. The following material has been sent out on our general exchange account:

United States National Museum, Washington, D. C.	1,926
New York Botanical Garden, Bronx Park, New York	717
Royal Gardens, Kew, England	2,156
Kgl. Bot. Garten, Berlin, Germany	2,052
Royal Botanic Garden, Calcutta, India	615
United States Dept. of Agriculture, Washington, D. C.	265
's Lands Plantentuin, Buitenzorg, Java	876
Botanic Garden, Sydney, N. S. W., Australia	238
British Museum, Natural History, London, England	1,688
Prince Roland Bonaparte, Paris, France	1,306
Museum de Histoire Naturelle, Paris, France	1,723
C. F. Baker, Los Baños, Laguna, Luzon	729
College of Agriculture, Los Baños, Luzon	600
Sarawak Museum, Kuching, Sarawak, Borneo	28
Rijks Herbarium, Leiden, Holland	1,425
F. Manson Bailey, Brisbane, Australia	145
National Herbarium, Melbourne, Australia	247

C. G. Lloyd, Cincinnati, Ohio	210
H. Winkler, Breslau, Germany	300
H. Sydow, Berlin, Germany	125
E. J. Butler, Pusa, India	157
T. Petch, Peradeniya, Ceylon	230
Royal Botanic Garden, Edinburgh, Scotland	1,419
T. Kawakami, Taihoku Museum, Taihoku, Formosa	352
Rev. Copland King, Ambasi, Papua	300
H. Yanagawa, Koshun, Formosa	150
Mauritius Botanical Department	178
Forest Research Institute, Dehra Dun, India	244
Carnegie Museum, Pittsburgh, Pa	679
N. Patouillard, Neuilly-sur-Seine, France	97
F. Bubak, Tabor, Bohemia	80
Total	21,255

On special exchanges, in addition to the above, there has been supplied to Dr. H. Sydow, Berlin, Germany, a total of 148 numbers of Philippine fungi, each represented by approximately 60 specimens; that is, about 8,800 specimens, for issue in his "Fungi exotici exsiccati," and to J. Kneucker, Karlsruhe, Germany, 4 species of Cyperaceae, 120 specimens each; that is, 480 specimens, for distribution in his "Glumaceae exsiccatae." In both cases the *exsiccatae* are received by the Bureau in exchange as the fascicles are issued.

In continuation of the botanical and book exchange arranged with T. O. Weigel of Leipzig, discussed in my last report, the following botanical material has been prepared and forwarded:

15 sets centuries XI, XII, Philippine plants	3,000
10 sets flowering plants, 300 specimens each	3,000
10 sets ferns, 60 specimens each	600
6 sets mosses, 100 specimens each	600
6 sets scale mosses, 75 specimens each	450
Total	6,650

For this material we have been credited with a total of ₱1,448 against which the Bureau may order botanical publications and material from the collections advertised for sale by Weigel in his periodical entitled Herbarium.

For all purposes, identifications, exchanges, etc., a total of about 39,200 duplicate botanical specimens have been distributed during the year.

The Bureau of Science is in exchange relations with somewhat over 60 institutions and individuals in various parts of the world, duplicates of Philippine material being exchanged

by this office for material from other tropical countries. During the past year exchanges have been arranged with—

C. G. Lloyd, Cincinnati, Ohio, for fungi.
H. Winkler, Breslau, Germany, for Bornean plants.
H. Sydow, Berlin, Germany, for fungi.
E. J. Butler, Pusa, India, for fungi.
T. Petch, Peradeniya, Ceylon, for fungi.
Royal Botanic Gardens, Edinburgh, Scotland, for Indian and Chinese plants.
Taihoku Museum, Taihoku, Formosa, for Formosan plants.
Copland King, Ambasi, Papua, for New Guinea plants.
H. Yanagawa, Koshun, Formosa, for Formosan plants.
P. König, Mauritius, for Mauritian plants.
R. S. Hole, Forest Research Institute, Dehra Dun, India, for Indian plants.
Carnegie Museum, Pittsburgh, Pa., for tropical American plants.
N. Patouillard, Neuilly-sur-Seine, France, for fungi.
Bureau of Plant Industry, U. S. Department of Agriculture, for fungi.
F. Bubak, Tabor, Bohemia, for fungi.

Exchange propositions are pending with several other individuals and institutions. In the past year exchange material has been sent to 35 different institutions and individuals, and material has been received from 20 different sources.

Publications.—The Philippine Journal of Science, Section C, Botany, for which the section of botany is responsible, has been successfully issued. The papers here published have been prepared by employees of this Bureau or by various other specialists, and are nearly all based on material supplied by the Bureau. A list of the articles published and publications issued during the year is given elsewhere.

In addition to the papers already published, several others are now in press, others are ready to be sent to the printer, and still others are in preparation.

Investigations.—The work of Mr. E. D. Merrill, chief of this section, so far as he is free from duties of botanical instruction in the University of the Philippines, still continues to be largely on questions of taxonomy and geographical distribution of plants. The Philippine collections made during the past year have been so extensive that there is work for several months in sight in properly classifying and distributing the material already prepared. The novelties to be found in these collections will be the basis or partial basis of several papers now in preparation or anticipated. Data recently secured in northern Palawan will be worked up into a paper on the relationship of the *caiñgin* system of agriculture to the various types of vegetation, and especially the great loss to the timber resources of the Islands from this system of clearing the forests and burning the fallen

trees. As opportunity is had, work is being done also on the collections of extra-Philippine plants from Borneo, Guam, and China. The material from the above regions comprises the collections made for the Bureau of Science in Sarawak, Borneo, through the kindness of J. C. Moulton, Esq., of the Sarawak Museum, 1,659 numbers; material from Guam secured by Mr. R. C. McGregor, by Mrs. M. S. Clemens, and through the kindness of Mr. J. B. Thompson of the Guam Experiment Station, 778 numbers; material from the Provinces of Shantung and Chihli, China, collected by Mrs. M. S. Clemens, about 800 numbers; and material from Annam, Indo China, collected by Dr. C. B. Robinson, 555 numbers. The last collection, however, is being named at the Museum d' Histoire Naturelle, Paris, France, to which institution a duplicate set was sent to assist the botanists there in the preparation of a flora of Indo China.

Doctor Robinson has given much time and attention to the collection and identification of botanical material on and near Mount Maquiling, and in this work has the coöperation of the botanists at the College of Agriculture at Los Baños. It is planned eventually to publish the results in the form of a critical enumeration with keys to the families, genera, and species. This work will be of very great value to the botanical department and the students of botany at the College of Agriculture, University of the Philippines, as it will enable one readily to determine the proper names of the plants found in the vicinity of the College. It will also be of great assistance to Doctor Brown of this Bureau, who is carrying on extensive physiological investigations on Mount Maquiling, in correlating his physiological data with the names of the plants found in the different habitats. Doctor Robinson's most important work, however, has been the development of the plans botanically to explore the Island of Amboina in the Molucca group, south of the Philippines, to which he was assigned some months ago. Amboina was early made famous in the annals of natural history by Rumpf, who resided there for many years, and who there wrote his great work entitled Herbarium Amboinense. This publication (1741–55) has been referred to by a great many botanists since the establishment of modern nomenclature, and very many of Rumpf's crude figures have become, by citation, the actual types of a large number of species. In critical groups it has proved to be impossible for later botanists properly to interpret many of these species from an examination of Rumpf's work alone, and no comprehensive botanical exploration of the island has been undertaken since Rumpf's death in 1702. We believe that

the species based on Amboinan material can only be interpreted correctly by the examination of a series of specimens collected in the localities given by Rumpf for his different species in relation to other data given by him, such as habitat, native names, uses, and dates of flowering and fruiting. In as much as the general flora of Amboina is very similar to that of the Philippines, many of our local problems in nomenclature can be solved by determining the exact status of those species based on Rumpf's figures. Attempts made by Stickman, by Linnæus, by Henschel, and by Hasskarl to determine the status of the Rumphian species have been only partly successful because those authors had little or no botanical material from Amboina. It can justly be claimed that this botanical investigation of Amboina is one of the most important pieces of taxonomic research to be prosecuted in the entire Malayan region. The Dutch botanists at Buitenzorg, Java, to whom the plan was submitted, have promised their full coöperation and support. To carry out the plan, Doctor Robinson left Manila on June 17 for Amboina, where he will spend some months in botanical exploration and observation. On his return it is our plan to study the material collected and to issue illustrative sets of Amboinan plants correlated, so far as possible, with those figured and named by Rumpf.

Doctor Brown has continued his observations and studies on the vegetation of Mount Maquiling, especially the relationship of the vegetation to environment, altitude, humidity, rainfall, soil moisture, and other factors. The problem is an exceedingly broad and complicated one, and new phases present themselves from day to day. The amount of instrumentation necessary and the great amount of routine involved keeping the instruments in condition, recording data, and interpreting the results will take practically all of Doctor Brown's time and energy for some months to come. No similar piece of work has been done in the tropics, and, for that matter, at no place in the world on such an extensive scale. The completed observations will form the basis of a series of very interesting and valuable papers on the relationship of different types of tropical vegetation to environment, and certainly demonstrate some facts of great economic importance.

Mr. Graff is prosecuting the work on various phases of Philippine mycology and vegetable pathology, in part identifying both the accumulated and current collections of Philippine fungi, preparing duplicate material for exchange purposes, and working on some problems in plant pathology. He has in hand

a proposed publication on Philippine plant diseases, in which he proposes to describe and discuss the different plant diseases already known from the Philippines with, as far as possible, nontechnical descriptions of the organisms causing the diseases, the characters by which they may be recognized, and methods of prevention and eradication. This work will be a basis for the further study and investigation of vegetable pathology in the Archipelago, a phase of botany that as yet has received but little attention in the Philippines.

Field work.—As in the past, it has been our object to have collections made, so far as possible, in regions not previously botanically explored. One native collector is kept in the field most of the time, while other members of the staff make trips from time to time for the purpose of botanical observation and the collection of material. The most extensive single collection made during the year was by Mr. Merrill at Taytay, Palawan, April 7 to June 7, 1913, of which no definite summary has been included. The collection comprises about 1,100 numbers, represented by about 15,000 specimens. Collections approximating 1,000 numbers were made by Mr. R. C. McGregor in Nueva Vizcaya Province and Ifugao subprovince. Extensive collections also have been made in the Provinces of Laguna, Tayabas, Rizal, and Bataan, Luzon, and in Leyte, Panay, Basilan, and Mindanao. A total of 5,066 specimens, from the collections made by employees of the Bureau of Science, have been incorporated in the herbarium. Miscellaneous collections made by employees of the Bureau of Forestry, chiefly tree species, amount to 1,065 numbers; this material has mostly been received in small lots from many provinces and islands.

ENTOMOLOGICAL SECTION OF THE BIOLOGICAL LABORATORY

Routine work.—Considerable time has been consumed in field investigation and collection of injurious and other insects when called upon either by private individuals or bureaus of the Government and in suggesting methods of combating such common pests as mosquitoes and flies. The routine work further consisted in mounting and accessioning of material and in arranging the same in the collection. The greater part of the collection has been rearranged.

Mr. Banks has spent considerable time in the supervision of the mosquito-extermination project carried out by the Bureau of Health, and has continued to give some instruction in the University. We are handicapped more than ever in the entomo-

logical work by the lack of a suitably trained Filipino assistant who can devote his whole time to the preparation of material.

We have a large amount of unmounted material on hand, and we should keep up with the specimens received. One thousand six hundred thirty new insect boxes ordered for the new wing of the building have been received and provide facilities for storing prepared material.

Accessions.—We have first accessioned rare material and species not represented in our collection. Even taking these facts into consideration, our numbers for the last year begin with 14,408 and end with 17,044, showing an accession of 2,636 lots (2,250 lots in 1912), or approximately 13,180 specimens ready for study.

Donations.—Fr. F. R. Sanchez, S. J., has donated a considerable number of insects collected either by himself or some of his students at various times and places during the year, many very desirable specimens having been taken at Mount Mirador, Baguio, Benguet. Many other individuals have donated single specimens to the collection.

Exchange.—Exchanges of insects have been effected with the following:

G. A. Waterhouse, Sydney, Australia, for Lepidoptera.
Germain Beaulieu, Ottawa, Canada, for Lucanidæ.
M. E. Walsh, Soekaboemi, Java, for Lepidoptera.

Classification and identification of material.—During the year Mr. Schultze has finished the manuscript of a catalogue of the Coleoptera of the Philippine Islands.

J. Weise, K. M. Heller, F. Ohaus, W. Horn, H. Gebien, and M. Bernhauer, eminent entomologists, have served us most zealously, both in the identification of material and in the preparation of papers for publication. The identification work is exceedingly important, as a well identified, systematic collection is the working base for economic problems. Our entomological publications which are mentioned elsewhere give full synonymy and literature references of about 2,200 species, and will be most important as an aid in referring to descriptive literature for the identification of Coleoptera with reference to economic questions.

Silk culture.—Through our efforts, silk culture is steadily increasing in the Philippines. It was introduced into at least one new province during the last year. We have been raising our stock of about 10,000 silkworms per generation. As it becomes necessary after some time to introduce new blood, we imported eggs of the monovoltine Japanese white silkworm from Japan

during the year, with the hope of crossing them with our stock. Unfortunately, most of the Japanese eggs died, probably due to abrupt climatic change. Sooner or later, we shall be obliged to obtain some fresh stock of silkworms of a polyvoltine race from India, for recrossing with our stock. The desirability of a thoroughly competent person to give his entire time to silk culture and its propaganda in the Philippines becomes more apparent each year.

Field work.—In November the sugar-cane leaf hoppers in Los Baños, Laguna, were investigated. A species of the genus *Perkinsiella* had been very abundant in small patches of sugar cane adjacent to the properties of the Calamba Sugar Estate Co., but it was found that a small egg parasite belonging to the genus *Paranagrus* was apparently holding the pest in check. This parasite is similar to a species which has been introduced artificially into Hawaii, and appears to be performing naturally the functions which those who work on sugar-cane insects in Hawaii have been obliged to obtain at much labor and expense.

From April 5 to June 7, 1913, Mr. Schultze was detailed on a biological expedition to Palawan, where a large number of new insects were found.

In April, Mr. Banks was detailed to Aparri, Cagayan, to take charge of the eradication of flies in that place, and subsequently to investigate the cacao pests reported from Ilocos Norte.

At Aparri, it was found that flies, similar in appearance and habits to the common house fly, were breeding under the most unexpected conditions; namely, in the large jars of macerated salt fish, known in that region as *bogoñg*, and extensively exported to various points in Ilocos Norte and Ilocos Sur. Public mass meetings for the enlightenment of the people on this subject were held, and the municipal authorities passed an ordinance compelling the manufacturers of this substance so to close their jars that it would be impossible for flies to have access to the contained material for the purpose of laying their eggs or, in case they had laid them previously, to prevent the escape of those flies or maggots which might develop therein. There has been a decided decrease in the number of flies in the town.

In Ilocos Norte numerous species of insects, hitherto not recorded as coming from cacao, were found on a large plantation established about twenty years ago and practically abandoned until within the past year. Collections of both the insects and the damaged plants were made, and certain material was brought to Manila for further study.

SECTION OF FISHERIES OF THE BIOLOGICAL LABORATORY

The ichthyologist was absent on leave in the United States from July 27, 1912, to January 3, 1913. During this time the helpers of the section of ichthyology were engaged in labeling specimens and transferring them to the permanent containers. The collection is in better shape than it has been for some time.

Economic work.—While in the United States, Mr. Seale visited some large sardine canneries and met the directors of these establishments in an effort to interest them in the establishment of sardine canneries in the Philippines. These directors requested numerous details, especially regarding the species of sardines and anchovies and their abundance, questions which could be easily answered from data derived from the investigations of this Bureau. The Booth Sardine Canning Co. was sufficiently interested to furnish a case of glass containers in which to send them samples of the Philippine sardines and anchovies in the salted state; this has been done. Sooner or later some of the large fish-packing firms will undoubtedly open establishments in the Philippines; this will be of great advantage to Philippine fishermen.

Window shells.—The demand for window shells has steadily increased during the past year, and we have received from Australia, Honolulu, and the United States letters requesting either shells or information regarding shells. The information desired has always been furnished, and requests for shells have been forwarded to Manila dealers. Owing to the increased demand for these shells, it was thought best to take some steps to insure an increased supply for the future. Therefore, a suitable bottom near Malabon was selected, properly marked on a chart, and 1,000 young window shells were transferred from the Kawit beds to this place. The number could be profitably increased to ten thousand or more.

Commercial button shells.—With the opening of the second button factory in Manila, the demand for shells to be used in the manufacturing of buttons increased as shown by the price of the top shell (*Trochus niloticus* L.), which has advanced from ₱8 to ₱20 per picul. This has stimulated the sale of these shells and a tendency to gather young and immature shells. We strongly urge that a law prohibiting the gathering of top shells less than 9 centimeters across the base be passed.

The black lip pearl-shell (*Margaratifera margaratifera* L.), which heretofore had not been gathered in very great quantities, is also now being taken in vast numbers for buttons. As this

is a shallow-water species, the supply will soon be exhausted unless a law is passed to prohibit the gathering of the young. Hundreds of young shells which are too thin to be made into buttons can be seen at the button factories where they are thrown out as useless. If they had been allowed to grow two more years, they would have been valuable.

For the first time in the history of the Islands the "scope" or "ear" pearl-shell (*Avicula micropterus* L.) is being gathered and made into buttons. This shell was considered of no value until Mr. Seale called the attention of the button manufacturers to its utility.

The desirability of taking the control of the pearl beds in the Christian provinces from the municipalities and placing it under the Department of the Interior is strongly urged. These beds should be charted, and an alternate third of them closed each year in order to maintain the pearling industry and allow the shells to mature.

Fish culture.—The black bass in the Baguio and Trinidad ponds have multiplied in a most satisfactory manner, and this season saw the inauguration of the first black-bass fishing in the Islands. According to regulations issued from the Department of the Interior, bass over 25 centimeters in length may be caught by fly fishing provided that all fishes under this length are promptly returned to the water. The fees charged are used to pay wardens. Bass were successfully transferred in December to the spawning ponds at Los Baños, where they are all alive and in fine condition and where they will probably spawn within the next three months.

Two dozen mosquito fish (*Gambusia affinis*) were brought from Honolulu on January 3, 1913. These were placed in an aquarium, in the section of ichthyology, where they have multiplied rapidly. Two hundred have now been planted in the swamps and fish ponds in the vicinity of Manila, and a stock of perhaps 100 still remains on hand. By actual count one of these little fish ate 500 mosquito larvæ in twenty-four hours; therefore, these fish are of direct importance to the public health, and their cultivation is worth our best efforts.

Scientific work.—A paper on the fishes of Hongkong, giving descriptions of several new species, is nearly completed, and a paper, The Edible Mollusks of the Philippines, was issued during the year. The identification of a number of small collections of fishes from various and numerous localities which have been sent in during the past year will be finished within

the next few months. A study and record of the spawning time and the migration and distribution of our principal food fishes are in progress.

Field work.—Several field trips have been made, and interesting collections secured from several localities, including Samai and Kawit in the vicinity of Manila. Considerable information has been obtained with regard to the distribution of the large food and game fishes of the Islands. Information has been given to the governor of Moro Province which it is hoped will lead to the protection and increase of the fisheries products and the improvement of the pearling industry in Moro Province.

In my previous report I have called attention to the fact that, aside from agriculture, the fisheries are of more importance than any other subject to a great number of the people of these Islands. We have at the present time but one trained man in the section of ichthyology, and a portion of his time is required in collecting for the aquarium. We should have at least one more American assistant and three educated Filipino apprentices in order to carry on the work properly.

SECTION OF COLLECTION OF NATURAL HISTORY SPECIMENS OF THE BIOLOGICAL LABORATORY

Because of the presence of a number of temperate region types, the birds of the highlands of northern Luzon are of especial interest. Collections made by the Bureau of Science at Irisan, near Baguio, in 1903 and at Pauai (Haight's) in 1909 contain specimens of nearly all of these highland species known from Luzon.

In 1912 additional specimens of some of these species were collected at Dupax and at Campote, Nueva Vizcaya.

In January, 1913, Mr. McGregor visited Dupax where collections were made in continuation of work of the previous year. The last week of January was spent at Payauan, while twenty days in the month of February were spent in collecting on Polis Mountain, Ifugao subprovince. A study of all these collections will show some interesting points in the local distribution of species.

In April and May, Andres Celestino was detailed to assist Governor-General Forbes in collecting birds in Mountain Province.

A few pieces of taxidermic work were prepared, but no effort is made to secure this kind of work because the taxidermist's time in Manila is very irregular.

No papers were written for publication.

CHEMICAL LABORATORY

This Bureau has continued to coöperate with the University of the Philippines and to give instruction in chemistry. During the last fiscal year Dr. Harry D. Gibbs, chief of the division of organic chemistry and assistant to the director; Mr. Robert R. Williams, Mr. Albert H. Wells, and Mr. J. del Rosario, assistants in the division; and Mr. T. Dar Juan, an assistant in the division of general, inorganic, and physical chemistry, were detailed for part of their time to instruction and administration in the department of chemistry of the University of the Philippines, and Dr. A. P. West, an assistant in the latter division, was detailed to give all of his time to instruction in the university. This assistance has been given to the university at considerable sacrifice of our own work on account of vacancies which existed in our staff of chemists. However, the head of the department of chemistry of the university especially requested the detail of several chemists for half time in order that he might have a greater number of assistants in handling the large classes. Except to enable the university to have a larger number of instructors at a given time, this arrangement is not the best for the Government, for it is easier to secure good instructors than it is to secure chemists capable of meeting the many requirements of this Bureau. The continuity of our work is destroyed by the detail of so many men. Resignations and readjustments in the Bureau of Science have left several vacancies, all of which will be filled as soon as practicable. Three new chemists sailed from San Francisco on June 28, 1913.

Physical research.—During the past year an extensive investigation of the electrical condition of the atmosphere has been begun in the Bureau of Science by the members of the department of physics of the University of the Philippines under the direction of Dr. J. R. Wright. This work is closely related to that recently carried on in the Bureau on tropical sunlight, and has an important bearing on the effect of a tropical climate on both animal and vegetable life.

A complete study of the electrical condition of the atmosphere involves a thorough investigation at different locations and at different altitudes of the following closely related factors:

(*a*) The total ionization of the atmosphere.
(*b*) The radium-emanation content of the atmosphere.
(*c*) The effect of the penetrating radiation from the radioactive products in the atmosphere and the earth's crust on the ionization in closed vessels.
(*d*) The variation of the electrical potential gradient.
(*e*) The absolute value of the intensity of the rays from the sun.

The variation of all of the above factors with the changes in the meteorological conditions is being made the especial point of investigation. Up to the present time simultaneous observations on all the different phases of the problem have never been attempted at any one laboratory, although frequently suggested as necessary.

Observations on the radium-emanation content of the atmosphere have been taken during the last year by two widely different methods. The first method, which is the one best adapted to the purpose, is the absorption of the emanation by charcoal made from the shells of coconuts and the direct comparison of the amount collected with that given off in a given time from a known amount of radium bromide. The other method, which is especially adapted to a study of the hourly variations of the emanation in the air, involves the collection on a negatively charged wire of the radioactive products of the emanation.

The data obtained from observations extending over a period of about sixteen months show that the radium emanation contained in the lower regions of the atmosphere per cubic meter is of the same order of magnitude as that found for Cambridge, England, and slightly greater than that for Montreal, Canada, being equivalent to that which would be in radioactive equilibrium with about 103×10^{-12} grams of radium. Observations by the radioactive deposit method have shown a diurnal variation with a decided minimum in the evening and a maximum in the early morning.

During the months of April and May, observations by the absorption method were taken at Pauai, Benguet subprovince, elevation 2,456 meters (8,060 feet), by Doctor Wright and Mr. Smith, for the purpose of determining the variation of the amount of emanation with altitude. The average amount of emanation per cubic meter was found to be equivalent to that which would be in radioactive equilibrium with about 24×10^{-12} grams of radium, as compared with 103×10^{-12} for Manila.

Work on the other above-mentioned factors entering into the electrification of the atmosphere is now under way, with the especial object in view of determining for a period of at least one year the relation existing between them and the changes in meteorologic conditions.

DIVISION OF GENERAL, INORGANIC, AND PHYSICAL CHEMISTRY

Mr. W. C. Reibling was appointed chief of this division on July 1, 1912. The work of the division has been seriously handicapped during the fiscal year 1913 by shortage of chemists and laboratory assistants. We have lacked the services of two first-class chemists which are provided for in our regular schedule of employees, and have been still further handicapped by the resignations of Messrs. Beyer and Paterno. On the other hand, the work of the chemists who were available suffered from the lack of trained laboratory apprentices, the considerable time required to train new assistants, and the repeated necessity of shifting chemists from one class of work to another.

Mr. Paterno was appointed on December 1, 1912, and it required several months of careful training on the part of Mr. Gana and others to teach him to be a competent water analyst. He resigned on April 15, just about as soon as his services had become of some value. Since then we have been training a civil-service employee, with the hope of obtaining much-needed help in routine analyses. Likewise, considerable time was lost in training Mr. Davis, who was appointed January 25, 1913, and transferred to the Bureau of Customs April 10, 1913. Mr. King, who was employed to occupy the position left vacant by Mr. Davis, has proved to be very capable and energetic. The vacancy left by Mr. Beyer on January 25 was filled about June 1.

ROUTINE WORK

The data in the table give a general idea of the routine done by this division during the last fiscal year, and for the purpose of comparison corresponding figures for the fiscal years 1910, 1911, and 1912 are included.

Nature of material.	Number of samples tested.			
	1910	1911	1912	1913
Rocks and minerals	----------	25	46	12
Soils, fertilizers, cements, and clays	3,342	3,738	8,636	9,617
Metals and alloys	24	46	36	45
Road materials, stone, gravel, sand, and concrete	----------	440	248	130
Water	82	164	146	197
Calorimeter determinations of fuels	----------	29	9	31
Boiler tests of coal	----------	10	2	----------
Standardizations of weights and measures (sets)	----------	1,066	990	1,127
Coal analyses	----------	154	20	58
Paint	----------	----------	----------	46
Miscellaneous[a]	248	----------	248	91
Total	3,696	5,672	10,381	11,354

[a] Work classified "Miscellaneous" in 1910 is largely segregated in 1911, 1912, and 1913.

All of this routine work was done at the request of officials in various departments of the Government and individuals representing private or corporate interests according to the figures given below.

Department.	1912			1913		
	Free work.	Cash work.	Total.	Free work.	Cash work.	Total.
Bureau of Agriculture	15		15	2		2
Bureau of Audits	1		1			
Bureau of Constabulary		7	7		2	2
Bureau of Customs	34	1	35	10	20	30
Bureau of Education	1		1		4	4
Executive Bureau		5	5			
Bureau of Forestry	3	5	8	2		2
Bureau of Health	40		40	56		56
Bureau of Internal Revenue	3		3			
Bureau of Quarantine Service					2	2
Bureau of Lands	12		12	5		5
Bureau of Navigation	10	30	40	1	3	4
Bureau of Posts	2		2			
Bureau of Prisons		1	1	2		2
Bureau of Public Works	49	2,246	2,295	96	3,932	4,028
Bureau of Supply	456	6,224	6,680	922	5,664	6,586
Bureau of Science	93		93	100		100
Weather Bureau	4		4			
City of Manila		179	179		29	29
College of Medicine and Surgery	2		2		180	180
Philippine General Hospital	6	2	8			
Provinces and municipalities		657	657		142	142
United States Army and Navy		71	71		180	180
Nonofficial	221		221			
Total	952	9,429	10,381			11,354

The number of samples of cement submitted for physical testing increased from 7,966 for 1912 to 9,617 for 1913. In addition to this numerical increase, the adoption of the new cement specifications has increased the work involved in the testing of a given number of cements by 50 per cent. The present capacity of the cement-testing laboratory is as great as economical conditions make advisable; but very often, owing to the present system for the purchase of Portland cement, as many as 800 or 900 samples have been submitted for test in two or three days while at other times we received very few samples for weeks. This alternate swamping and stagnation of the cement-testing force is very difficult to meet. The work could not be turned out promptly under such conditions unless we were to keep available at all times a very large force of trained workers, and, if we did

this, a greater part of the force would be idle about half of the time. Our capacity soon will be 65 samples per day, or 16,250 samples per year of 250 work days. This will enable us to turn out about 1,400 tests a month, and it seems that, with a little care and judgment on the part of those most responsible for the purchase and use of Portland cement, the swamping of our force could be avoided. Obviously, we could increase the testing capacity to any desired figure; not, however, without a correspondingly large additional cost to the Government.

While there has not been a corresponding increase in the demand for tests of road materials, the work now done on each sample is much greater than when it was customary to request only an abrasion test. Local engineers now demand a complete examination, including abrasion, hardness, toughness, cementive value, fracture, and classification; and lately they are giving consideration to the chemical and physical properties of tars, asphalts, bitumens, and oils intended for use on local roads.

The Bureau of Science has pointed out the advisability of a more systematic and coöperative study of the efficiency of available road materials under actual conditions of local climate and traffic, but little has been done along this line so far as we know.

It frequently happens that a request for information concerning the composition, value, or utility of a sample involves a lengthy and complicated examination. At other times a correct interpretation of the results obtained cannot be given without much study and considerable research work. Among such requests received during the past year were the following:

1. To state from the results of analyses the relative efficiency of different kinds of prepared bituminous roofing felts.

2. To determine the suitability of 23 different raw materials for the manufacture of Portland cement. This involves a great amount of work as it is necessary not only to analyze each material, burn the most promising mixtures obtainable from the same, and subject the final product to routine test, but also to study the effects of different degrees of liming, burning, seasoning, and plastering.

3. To determine from the results of analyses the relative efficiency of different kinds of paints and protective coatings, taking into consideration the local conditions such as are met with according to whether the material is subjected to the action of sea water, fresh water, or air.

4. To ascertain a practical method for bleaching low-grade hemp fibers and rope, Malacca cane, etc.

5. To determine the cause of foreign deposits in the product of a local artificial ice plant.

6. To solve problems connected with the creosoting of local timber.

7. To determine the cause of the rapid corrosion of certain kinds of iron and other metallic structural materials.

8. To determine the value of clays and shales for ceramic purposes.

9. To determine the composition or formula of such manufactured products as electric batteries, paints, waterproofing compounds, etc.

10. To determine the apparent and relative value of different kinds of road materials, including clays, crushed stones, gravels, asphalts, oils, and bitumens.

11. To endeavor to find the cause of certain epidemics from waters which apparently are potable.

12. To determine the cause of failure in materials of construction.

13. To classify different samples of Babbitt metals and lubricants in their true order of merit.

14. To test and analyze the 19 different kinds of roofing materials submitted in a recent contest for a substitute for nipa roofing and report on their relative efficiency. In most instances it was necessary to devise special methods of analysis in order to prove the correctness of the formulas submitted by the contestants.

The large amount of work accomplished by this division, handicapped as it has been by such unavoidable conditions, is, in itself, sufficient proof of the diligence and ability of Messrs. Beyer, Gana, Dar Juan, Reyes, King, and Arguelles who at all times did the work assigned to them in a very satisfactory and painstaking manner and often worked overtime and on holidays in order to keep up with the work.

RESEARCH WORK

The published research is included under the heading The Philippine Journal of Science and other publications.

Under my direction the study of the oxidation of coal, Philippine soils, and the local manufacture of salt has been continued.

Considerable work has been done by myself, Mr. W. C. Reibling, chief of this division, and Mr. V. Q. Gana on a paper dealing with the water supplies of the Philippine Islands. The completed publication will involve a great amount of work, only about half of which has been done. The paper should be finished as soon as possible, especially on account of the many important considerations included.

The subject of corrosion and protective coatings is a very important one, and the necessity of a thorough investigation along these lines is becoming more and more essential. Thousands of dollars have been wasted through the rapid deterioration of metallic structural materials and protective coatings. Many of these apparently give very satisfactory services in other parts of the world, but they deteriorate very rapidly here where the climatic conditions are so different. We have segregated important references to the literature of the subject and sent

numerous requests to manufacturers for samples of paint, pigments, and oils, to which they have responded very heartily, and some of them have contributed valuable information. They are looking forward with considerable interest to our results. On the other hand, we receive numerous requests for information on the same subject from the users of such materials. Eventually, we hope to investigate the value of local vegetable oils, gums, and resins as raw materials for protective coatings. Paint consumers and manufacturers have sought for a vehicle which will be less easily saponified by alkalies or oxidized by the atmosphere after drying, and perhaps the vegetable life of this country will furnish a more resistant product than any at present known.

The special committee appointed by Executive Order No. 32 (1913) has requested a special appropriation to carry on research work here for the primary purpose of investigating the efficiency of various kinds of galvanized iron. It is hoped that means will be supplied to carry the investigation at least far enough to enable us to purchase all materials of construction according to specified requirements which will guarantee satisfactory service. The specifications adopted by other countries cannot be relied upon to give satisfaction here for reasons already mentioned.

Six or seven months ago samples of galvanized iron from buildings in the provinces were secured which were in excellent condition after many years of service. Others were badly corroded, although they had been exposed for a few years only. We had hoped to complete a thorough study of these samples and ascertain the cause of their relative value. This work will be done as soon as time will permit.

Work on the expansion of Portland cement mortars under different conditions of exposure and two important problems involved in the manufacture of sand-lime brick and natural cement, begun some time ago, have been practically at a standstill owing to routine work.

More than a year ago, at the suggestion of Doctor Freer, the chief of this division began very important studies on the chemical and physical properties of fused cement mixtures. He has built a satisfactory furnace, and the results obtained from the preliminary burnings indicated that this line of work possessed possibilities of great scientific and commercial importance. This work demands his personal attention, much of which he has had to give to other things.

It has been the constant endeavor of cement manufacturers and users to develop a quick and reliable test for Portland cement, and recent experiments with the autoclave test indicate a possible solution of the problem. However, the autoclave test cannot become of value until the significance of the results obtained are thoroughly understood. A thorough study of this test has been begun, but the investigation has only reached the preliminary stage.

Samples of soft rock from Nueva Ecija submitted by the Bureau of Public Works for valuation as a road material proved to be hardened clay which apparently possessed many of the properties of a material suitable for the manufacture of vitrified brick. A few trial mixtures gave very promising results as well as evidence that the clay would have to undergo special treatment for use in paving brick. Owing largely to the energy of Mr. King, who worked on the problem outside of the regular working hours throughout the hot season, we have obtained very satisfactory products.

Our investigation of raw materials to determine their suitability for the manufacture of lime; hydraulic, Roman, and Portland cement; and sand-lime brick has been continued, and materials which proved satisfactory will be subjected to the conditions of actual manufacture in a new lime kiln of 500 pounds' capacity, which we have just completed.

A large number of problems of industrial and economic importance await time and opportunity to investigate them.

DIVISION OF ORGANIC CHEMISTRY

Personnel.—Dr. Harry D. Gibbs, chief of the division of organic chemistry and assistant to the director, has been absent on leave since the beginning of the calendar year, and the work of the division has been under the direct supervision of Mr. R. R. Williams and Dr. D. S. Pratt. Mr. Williams resigned on June 15, to go into commercial work in Manila, and Mr. J. del Rosario and Mr. E. R. Dovey resigned on September 30, 1912, and June 1, 1913, respectively. Mr. Williams will continue to devote a portion of his time to research work in the Bureau.

ROUTINE WORK

The routine work alone of the division has been of as wide a variety as in previous years, and has practically consumed the time of three chemists and a part of that of others. Aside from two classes of samples mentioned below, this work has shown

a material increase, and the actual work involved is as great as that performed during any year since the organization of the Bureau.

Nature of sample.	Number.				Total.
	Examined under Act 1655.	Adulterated or misbranded.	Government work (not included under Act 1655).	Private work.	
Meats	57	1	1	1	59
Fish	75	2	1	1	77
Dairy products	71	20	152	28	251
Vegetables	39	8	2	3	44
Farinaceous products	37	7	26	9	72
Vegetable beverages	76	20	3	4	83
Sugar	72	1	1	76	149
Candies	30	14			30
Fruits	26	6	8	3	37
Condiments	47	5	2		49
Cattle feeds			21	1	22
Copra				6	6
Paper and textiles			133	3	136
Oils		1	39	2	41
Soaps			4	5	9
Paints			22	9	31
Miscellaneous	1		15	18	34
Opium	1	1	84	1	86
Essences	29	4	5	29	63
Nonalcoholic beverages	45	17			45
Alcoholic beverages	18	6	18	6	42
Food colors	16	1	1	3	20
Drugs	45	21	23	5	73
Medical	12	1	216	22	250
Sugar cane			18	22	40
Total	697	136	795	257	1,739

In all, 1,739 samples have been examined, distributed as shown in the above table. The total number of samples has decreased from 1,921 last year, or 8.9 per cent. This decrease is confined to two classes of samples; namely, raw sugar and urine (medical analyses). These analyses are very simple and quickly performed, and do not reduce the work of the division in proportion to the number. Raw sugar samples have decreased on account of the large proportion of low-grade sugar produced this year. In the commercial grading of sugars the distinctions between the low grades are much less finely drawn than in the case of the high grades, and polarizations are usually unnecessary. Most of the routine examinations of urines have been transferred to another branch of the Bureau. Pending a satisfactory settle-

ment of a standard for carabaos' milk and a further investigation of the local conditions of infant feeding, the health authorities have ceased to submit any large number of fresh milks. In the above numbers are included 124 samples of carabaos' milk which this Bureau has collected and analyzed in order to furnish data for the much-needed standard and to supply information which will improve this important native food product, especially for invalids and infants.

The number of samples examined under Act 1655 was 697 as compared with 637 last year. The number adulterated was 136 as compared with 171 for last year. The Foods and Drugs Act has been more strictly enforced, especially with reference to products of local origin than has been possible previously. The first legal prosecutions have been made this year under Act 1655. Sixteen prosecutions have been instituted, with a result of 10 convictions and 6 cases pending. The enforcement of the law with regard to imported products has been satisfactorily rigid for some years. However, its enforcement with respect to domestic products is believed to be of much greater import to the health of the native population.

The amount of Government work, that is, work performed for all branches of the Philippine and Federal Governments, exclusive of that done under Act 1655, is increasing as is that done for private parties. Nearly all the work of the division is rush work. For example, all imported samples examined under Act 1655 are held at the Custom House pending the result of analysis, and the work must be done promptly. All perishable samples must be treated in the same way. Paper and certain samples of distilled liquors are the only important exceptions. Work which does not need to be completed immediately is used to fill in short leisure periods which are valueless for research work, especially since one can never be certain when such leisure periods are going to occur. The plan, which is now in use and has proved satisfactory in the medical section of the biological laboratory, of assigning certain men for research work and others for routine, is being considered with reference to this division. Under this system two or three men could carry the burden of all routine work except perhaps an occasional sample of unusual character. It requires men of considerable ability and, above all, experience to carry on the diversified routine work of this Bureau, and this experience is not the same that fits a worker for special research. It may be that this plan will result in a great economy to the Bureau.

RESEARCH AND INVESTIGATION

The volume of the research contributed by this division during the year is indicated by the fact that 14 articles have been prepared for publication, 1 is in preparation, and work is in progress on 4 other problems. The authors and titles of the published articles are given under the heading The Philippine Journal of Science and other publications.

I desire especially to mention the work done on the nipa palm as a source of sugar. This arose from an experiment on a large scale, the results of which have led to investment in an enterprise to utilize the nipa swamps of the Islands much more effectively. This may well be expected to lead to large results in the industrial development of the Islands.

There is need for continuation of the investigations of copra, but we have not been able to do this during the past year. This work should be taken up again and carried out thoroughly with the object of devising and putting into general use an inexpensive but effective kiln for drying copra. A quick commercial method for grading copra should also be devised, and efforts be made to induce local copra merchants to do their buying on a more scientific basis. The data as yet collected on this subject are fragmentary and useless until supplemented by further work, especially in the field.

The report of the Iloilo sugar laboratory is made separately on page 107.

DIVISION OF MINES

Personnel.—Dr. Warren D. Smith, chief of this division, returned on October 2, 1912, from leave in the United States where he had been investigating the most important oil fields in California. He studied the situation from the points of view of the geological features and the methods of the geologists; drilling operations; pumping methods; the distribution of the product, including storage and marketing; refining; the leasing system; and legislation. This investigation will increase the reliability of the judgment of the geologists of this Bureau with regard to the practical side of our study of the Philippine oil fields. Mr. Percy D. Kincaid was appointed a temporary employee on August 25, 1912. Mr. F. T. Eddingfield went on leave on November 25, 1912, and returned June 5, 1913. Mr. F. A. Dalburg has been on leave since May 7, 1913. Mr. P. R. Fanning left Manila on June 15, 1913, to spend his leave in the United States. He will attend the Congrès Géologique Internationale in Toronto as a delegate from the Philippines.

ROUTINE WORK

During the year 242 assays for private parties, including 2 free assays for prospectors in new districts, and 439 assays on research work, besides 19 bullion assays were made. This shows a slight increase over the number of assays made during the previous year, which is surprising when one considers that installations of assay offices at the Colorado mine, Masbate, and the Headwaters mine, Benguet, have been made, and also that a number of quartz prospectors have transferred their attention to placer deposits. At the present time, owing to the small number of assays received, this Bureau is carrying on the work at an actual loss of ₱0.88 each. However, this seems warranted when one considers the great service to prospectors and engineers in enabling them to obtain accurate and reliable results.

As heretofore, there has been a continued demand for the services of the geologists to make field investigations on geological or engineering problems of strictly economic value. All of the investigations undertaken for private parties have been carried on in order to discover the economic possibilities of various deposits and thereby to aid in advancing the mining industry.

Geological reconnaissance work has been carried on in various parts of the Archipelago. The geologists have not visited so many places as formerly, but the work has been carried on in a more intensive manner. Three large relief maps of the Philippine Islands, the stone work for 2 medium-sized lithograph maps in three colors, 12 original maps, 21 tracings in ink, as well as a number of free-hand drawings, arrangement of illustrations, etc., have been made by the artists.

INVESTIGATIONS

The Mineral Resources of the Philippine Islands for 1912 is nearly ready for the press. It will contain the following articles:

Review of the year, by Warren D. Smith.
Statistics of production, by F. A. Dalburg.
Status of mining claims, by F. A. Dalburg.

THE METALS

GOLD:

The Paracale district, by Paul R. Fanning.
The Aroroy district, by Percy D. Kincaid.
The Baguio district, by Warren D. Smith.
Other districts, by Frank T. Eddingfield.

IRON:

The Angat district, by F. A. Dalburg.
Other metals, by F. T. Eddingfield.

THE NONMETALS

The production of nonmetals in 1912, by Wallace E. Pratt.
General features of coal mining in 1912, by F. A. Dalburg.

SPECIAL ARTICLES

Petroleum on Bondoc Peninsula, Tayabas, by Wallace E. Pratt and Warren D. Smith.
Sand-lime brick and artificial sandstones in the Philippines, by Alvin J. Cox, W. C. Reibling, and F. D. Reyes.
Contribution to the metallogeny of the Philippines, by Paul R. Fanning.

The details of papers which have been prepared and published in The Philippine Journal of Science will be found in another place under that head, but especial attention may be directed to the following research completed during the year:

Ore-testing investigations.—Many important laboratory tests looking to the most efficient treatment of Philippine gold ores have been carried on. Tests have been made on samples sent in from three properties in Masbate, samples from the Paracale dredges, and from Benguet. This work has been supplemented by extended operations at the mills and on the dredges, and the operation of one mill was studied for one month with the result that it was shown where considerable savings and improvements could be made.

Tayabas oil fields.—The most complete survey ever made of any of the prospective oil fields in the Philippines has been completed in Tayabas Province.

Natural gas.—A well, reported to be emitting large volumes of natural gas at Oas, Albay Province, was examined. The public interest was so great that the matter was looked into in spite of our anticipation that it was a pocket of swamp gas, which proved to be true.

New reservoir site for the city of Manila.—A very careful and important examination of a proposed reservoir site for the city of Manila near Mariquina has been made. This work involved questions of seepage, supports for an earth-fill dam, and material for such dam. The results are greatly appreciated by the water-works engineers, and demonstrate the value of careful geologic investigation with reference to engineering projects.

Geologic and topographic work in Mindoro.—Geologic and topographic notes to be incorporated in the main report of a medical survey of the San José estate in Mindoro have been made.

Palawan.—A second geologic exploration trip to Palawan fur-

nished some interesting rock specimens. A small lake possibly never before visited by white men was explored and mapped.

The Cebu typhoon.—Investigations of the destructive tidal wave in Cebu in October have shown that the Osmeña dam site suffered considerably in the place where a geologist of this Bureau had previously pointed out a probable weakness.

Water resources of Panay.—Doctor Smith spent three weeks in Panay investigating the ground-water resources of a portion of Iloilo Province. He was able to arrive at the following definite conclusions:

1. The sedimentary formations could not be feasibly tapped to produce a sufficient supply of potable water.
2. The buried gravels of the Iloilo delta showed favorable possibilities in this direction.
3. The gas and salt-water well at Janiuay is an indication of the possibilities for a petroleum supply somewhere in that region.

Material was secured on this trip to make a contribution to the geology and physiography of that none too well-known island.

Ore deposits.—A number of experiments on the principles controlling the deposition of gold in quartz-calcite-manganese veins and important contributions to the metallogeny of the Philippines have been made.

Geologic work.—More or less interrupted investigations in various regions have given data on Philippine stratigraphy, which have led to a revision of the table of the sequence of Philippine formations, and other information which will be used in future monographs and other publications.

DIVISION OF ETHNOLOGY

There has been no change in the personnel of this division during the year. Since the disastrous fire which occurred in the vicinity of the museum on Calle Juan Luna in November, 1911, only new buildings of concrete have been built, so that the museum is in no great danger from fire from the rear or south end. At my request, the Bureau of Public Works has recently finished a fire wall at the north end of the museum where the building joins property occupied by Chinese. This wall was built on top of the old stone wall one story in height, extends 1 meter above the roof, and makes the museum as safe from fire as it can be in its present location. When the museum was disarranged with building operations and the laborers were at hand, the storeroom and the smaller office, which formerly

almost divided the museum into 3 small exhibit spaces, were removed to the extreme northern end of the building. On the eastern side of the second floor we now have one long room uninterrupted by partitions. The partition around the stairway, which was formerly over 2 meters high, has been cut down to the height of a hand rail. These changes make the museum lighter, and give the appearance of more space. There has been a large number of visitors this year, especially during the afternoons of the summer season when the museum was kept open and was visited by many people who formerly had found the hours inconvenient.

The investigation of the Ilocano people, begun the year before last, was continued, except for two short interruptions, by field study until May 16, 1913. With the possible exception of one short journey, which may be necessary, the field work is completed. The office work upon the report will now proceed without interruption.

Work on the general ethnology of the Ifugaos has progressed steadily. The finished report will consist of several parts. The first of these, that on the grammar of the Ifugao language, is completed; three other parts are almost finished, and much work has been done on the remainder. It is expected that the entire report will be ready for the printer some time during this calendar year.

A Bontoc vocabulary, prepared by Miss Margaret P. Waterman of Bontoc, and a manuscript by Lieut. Charles W. Elliott on the Lanao Moro dialect, submitted to the Bureau of Science, have been prepared for the printer, and are ready for publication.

Mr. Garvan spent over two months in Tayabas studying the Negritos and Dumagats of that region. Among much valuable information which be gathered was a vocabulary from the Negritos. He has since visited the Negritos of Bataan Province and gathered a vocabulary from them. The report on the Manobos of the Agusan Valley is finished, and has been submitted for publication.

In December Doctor Miller went to Iloilo to investigate reports of interesting caves in Iloilo, Capiz, and Negros Provinces. In one cave in Capiz he found a coffin, well preserved but empty, which was sent to Manila. In no other caves did he find any relic of interest. The reports which had come to us about manuscripts having been found in certain caves of Negros could not be substantiated.

We have added 557 new specimens to the museum collections during the year distributed as follows:

Ilocano (5446–9, 5464–5501, 5849–6054, 6101–7, 6140–1, 6204, 6250–6346)	355
Bontoc (5712–5848)	37
Australian sponges (6147–6203)	57
Australian stone implements (6349–6360)	12
Negritos (6362–6398)	37
From various sources (5045, 6055–6100, 6205, 6242–9, 6347–8, 6361)	59
Total	557

In addition to the above, the following numbers have been added to the museum catalogue by assigning numbers to specimens previously on hand but included as duplicates under other numbers: 5501–5711, 6108–6139, 6142–6, 6206–6228.

The most important addition has been the Ilocano collection. This collection is valuable in itself, and especially because it marks the beginning of exhibits from the Christian people of the Philippines.

The first collections placed in the museum were those returned from the St. Louis Exposition. They consisted almost entirely of specimens from the non-Christian people of the Islands. For several years after the opening of the museum, field work was carried on among the non-Christians only; for this reason, we were unable to obtain collections illustrating the life of the Christian people. At the same time that the study of the Ilocano people was undertaken, a collection from them was begun for the museum. This collection is now practically completed. As soon as the report on the Ilocanos has been finished, we hope to undertake an investigation and obtain similar collections among some of the other Christian peoples.

We have made the beginning of a collection to illustrate methods of transportation on land and water in different parts of the Islands. Models illustrating land transportation are being made uniformly one-half size. There is such a wide range in the size of boats used on the ocean and on rivers that it has been found impracticable to adopt a uniform scale in illustrating water transportation. We have a few boats of full size and a few made on a reduced scale. Until a large museum building is available in which large boats can be exhibited, it will be necessary to follow this plan. This transportation exhibit when complete will be very interesting and will show what a wide variety of means of transportation is in use in the Islands.

LIBRARY

During no year in the history of the Bureau has more progress been made in the permanent organization of the library and in improving methods of routine work. A number of favorable conditions have contributed to this result. The new quarters have given us room to shelve books promptly. The stacks are well lighted and easy of access from the charging desk. The arrangement of the stacks in relation to the charging desk has made it possible for the assistant responsible for the charging desk to do other work when not actively engaged in charging and discharging books or in recording charging records. No changes in the civil service personnel have occurred, and few apprentices have resigned, thus giving a better trained staff than in any previous year. No long absences have occurred either from illness or from employees taking accrued leave. The possession of an excellent union catalogue for reference and comparison has reduced the time spent in reference work, and has been extremely valuable for comparison in classification and in the assignment of subject headings.

The hours during which the library is open are from 7.30 a. m. to 9.30 p. m. from Monday to Friday, 7.30 a. m. to 5 p. m. on Saturday, and 9 a. m. to 12 m. Sunday and holidays. This has been in effect since December 1, 1912, with no change during the summer season. The number of visitors during the late afternoon and evening hours has not been large, but for the most part they have been serious workers, many of whom could come at no other time of the day.

Orders.—Orders for books estimated to cost ₱24,129.13 have been placed during the year, and of these, publications amounting in value to ₱9,458.27 have been delivered, leaving ₱14,670.86 worth undelivered. In addition to these, orders placed during preceding years have been delivered in the amount of ₱3,692.11.

Accessions.—The number of bound volumes accessioned was 3,852; 1,690 by binding and 2,162 from other sources. The total number of bound volumes in the library on June 30 is 26,652. Among the most important works received during the year are the following:

NEW PUBLICATIONS

Adams. The zoölogy of the voyage of H. M. S. Samarang; under the command of Captain Sir Ed. Belcher . . . during the years 1843–1846 . . . Crustacea, 1848.

Agassiz. Bibliographia zoölogiae et geologiae. A general catalogue of all books, tracts, and memoirs on zoölogy and geology, 4 vols., 1848–1854.

American association for the study and prevention of infant mortality. Transactions, 2 vols., 1910–1911.

Beccari. Nelle foreste di Borneo, 1902.
Beechey. The zoölogy of Beechey's voyage to the Pacific in H. M. S. Blossom, 1839.
Bleeker. Atlas ichthyologique des Indes orientales néerlandaises, 8 vols., 1862–1878.
The Bradley bibliography. A guide to the literature of woody plants, 2 vols., 1911–1912.
Bronn's Klassen und Ordnungen des Thierreichs, 27 vols., 1880–1911.
Burmeister. Handbuch der Entomologie, 7 vols., 1832–1855.
Costigan. Handbook on American mining law, 1908.
Darbishire. Breeding and the Mendelian discovery, 2d ed., 1912.
Distant and Champion. Biologia centrali-americana. Insecta. Rhynchota. Hemiptera-Heteroptera, 2 vols., 1880–1901.
Duperrey. Voyage autour du monde, 3 vols., 1826–1830.
Encyclopedia Britannica, 11th ed., 29 vols., 1910–1911.
Gardiner. Fauna and geography of Maldive and Laccadive archipelagoes, 2 vols., 1901–1906.
Gomes. Seventeen years among the Sea Dyaks of Borneo, 1911.
Guppy. Observations of a naturalist in the Pacific, 2 vols., 1903–1906.
Imperial cancer research fund. Scientific reports on the investigations of the Imperial cancer research fund, 5 vols., 1904–1912.
Kayser. Handbuch der Spectroskopie, 6 vols., 1900–1912.
Lamarck. Histoire naturelle des animaux sans vertébres, 7 vols., 1815–1822.
Latreille. Histoire naturelle, générales et particulière des crustacés, 14 vols., 1802–1805.
Milne-Edwards. Expeditions scientifiques du Travailleur et du Talisman, 8 vols., 1888–1906.
The mining magazine, 3 vols., 1910–1911 (1 vol. lacking).
Notes from the Leyden Museum, 35 vols., 1879–1912.
Novara Expedition. Crustacea, Mollusca and Anneliden.
Oken. Allgemeine Naturgeschichte für Allestände, 15 vols.
Progressus rei botanicae, 3 vols., 1907–1912.
Résultats des campagnes scientifiques accomplies sur son yacht par Albert I, Prince Souverain de Monaco, 40 vols., 1889–1912.
Sajous. Annual of the universal medical sciences, 45 vols., 1888–1896.
Saville-Kent. The great barrier reef of Australia, 1893.
Science abstracts. Physics and electrical engineering, 23 vols., 1898–1913.
Seligmann. The Melanesians of British New Guinea, 1910.
Shamel. Mining, mineral and geological law, 1907.
Siboga-expeditie. Résultats des explorations zoologiques, botaniques, oceanographiques et géologiques, entreprises aux Indes Néerlandaises Orientales en 1899–1900 à bord du Siboga, 63 vols.
Société zoologique de France:
Bulletin, 36 vols., 1876–1911.
Memoirs, 24 vols., 1888–1911.
Veth. Midden-Sumatra, 8 vols., 1881–1892.
Volz. Nord-Sumatra; Bericht über eine im Auftrage der Humboldt-Stiftung der königlich preussischen Akademie der Wissenschaften z. Berlin in den Jahren 1904–1906 ausgeführte Forschungsreise, 2 vols., 1909–1912.
Weber. Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien, 4 vols., 1890–1907.
Wood's Library of standard medical authors, 100 vols., 1882–1887.

Ziemssen. Cyclopedia of the practice of medicine, 16 vols., 1874–1877.
Zoologica: Abhandlungen aus dem Gesamtgebiete der Zoologie, 25 vols., 1888–1911.

SETS COMPLETED

Albrecht von Graefe's Archiv für Ophthalmologie, 72 vols., 1854–1902.
Annales des sciences naturelles, 182 vols., 1824–1904 (8 vols. lacking).
Annales mycologici, 3 vols., 1903–1905.
Annals of surgery, 22 vols. 1891–1911.
L'Anthropologie, 18 vols., 1890–1903.
Archiv für Kinderheilkunde, 45 vols., 1880–1907.
Archives d'anatomie miscroscopique, 5 vols., 1897–1903.
Chemiker-zeitung and supplement, 74 vols., 1878–1905.
Deutsche tierärztliche Wochenschrift, 10 vols., 1893–1902.
Dutch East Indies. Jaarboek, 4 vols., 1904–1905, 1907–1908.
Folia haematologica, 4 vols., 1904–1907 (1 vol. lacking).
Fortschritte der Chemie, Physik, und physikalischen Chemie, 4 vols., 1909–1911.
Frankfurter Zeitschrift für Pathologie, 8 vols., 1907–1911.
Gegenbaurs morphologisches Jahrbuch, 38 vols., 1876–1908.
Journal de physique, theorétique et appliqués, 40 vols., 1872–1911.
Journal of cutaneous disease, 15 vols., 1888–1902.
Journal of physical chemistry, 10 vols., 1898–1907 (1 vol. lacking).
Liverpool marine biology committee. Memoirs. 17 vols., 1899–1908.
Medical record, 29 vols., 1886–1900.
Naples. Zoological station. Mittheilungen, 18 vols., 1879–1908.
Novitates zoologicae, 14 vols., 1894–1908.
Physical review, 29 vols., 1893–1909.
Semaine médicale, 16 vols., 1882–1893, 1899–1902.
Das Tierreich, 29 vols., 1897–1911.
Wiener medizinische Wochenschrift, 2 vols., 1851–1852.
Zeitschrift für wissenschaftliche Zoologie, 78 vols., 1849–1898.
Zentralblatt für Chirurgie, 35 vols., 1974–1908.
Zentralblatt für die gesamte Physiologie und Pathologie des Stoffwechsels, 9 vols., 1900–1908.
Zentralblatt für Physiologie, 24 vols., 1887–1910.
Zoologische Jahrbücher, 58 vols., 1886–1908 (2 vols. lacking).

Binding.—Eight hundred forty-nine volumes were at the bindery on July 1, 1912; 1,500 volumes have been sent since, and 1,529 returned, leaving 820 volumes still undelivered.

Classification.—All new material has been classified promptly as received and the old material of a miscellaneous character somewhat reduced. There is very little unclassified scientific material remaining, although some of the publications will be valuable as reference material when made available. All catalogues of universities, colleges, medical colleges, and technical schools have been included under the regular classification schemes and placed on the shelves according to regular Library of Congress class numbers. The better trained Filipino assistants are showing great interest in the subject of classification,

and are becoming very helpful in this branch of library work. It is hoped that all material in the library eventually may be classified according to one classification system, so that cards representing the entire content of the library may be included in one shelf list. College catalogues are already so included, the work on trade catalogues has been begun, and a scheme has been worked out to apply to maps, charts, and blue prints.

Cataloguing.—A typewritten list of author headings for government documents, based, for the most part, on Library of Congress usage, has been prepared by the assistant librarian. Subject headings have been unified, and a large number, including all used to date, filed in alphabetical order, with the authority for the form adopted. Here also Library of Congress usage predominates. Subject work has been completed for all new material as received and for all publications returned from the bindery. In addition, classes A–J inclusive have been entirely completed.

The following table shows the technical work performed:

Nature of material.	Classification and cataloguing (new material).	Reclassification and assignment of subject heading (old material).
Books:		
Bound volumes	3,743	634
Unbound volumes	3,391	292
Parts	2,079	151
Total	9,213	1,077
Cards:		
Shelf list	1,136	194
Main catalogue	4,071	1,307
Total	5,207	1,501

Printed cards.—The extension in the use of Library of Congress printed cards by the different libraries will more and more tend to bring about uniformity in all matters in which they differ. After a careful test of the cost of typewritten cards in comparison with that of printed cards, the result was so overwhelmingly in favor of the latter, that an order was placed for ₱1,500 worth of Library of Congress printed cards. This first order included cards for serial publications only, the individual numbers of which are separate monographs; for example, U. S. Geological Survey, professional papers, the separate bulletins of the U. S. Bureau of Chemistry, and the different papers included

in the Siboga Expedition, and covered nothing not already in the library or ordered. I desire to order all available printed cards for publications in series and the cards, printed by the Royal Library at Berlin, for inaugural dissertations as soon as funds are available. It is probable, that by securing cards from various sources a large proportion of all our serials may be analyzed in the near future.

Union catalogue.—The largest single piece of work accomplished during the year is the completion of the filing of the union catalogue, consisting of one copy of the author card for each title. This catalogue consists of Library of Congress printed cards, Library of Congress proof, cards printed by the John Crerar library during one year, and those printed by the American Library Association for two series. This catalogue now occupies 196 card cabinet and sorting trays, and contains approximately 325,000 cards.

Photographs.—To give more adequate protection against fire, the collection of photographic negatives, now amounting to 16,200 five by seven, and 1,250 eight by ten, negatives, has been moved into the library and placed in an accessible place on the second floor.

Cuts.—The Bureau of Science collection of cuts, numbering approximately 3,800, has been carefully identified by comparison with the prints and numbered with steel dies in such a way that this record cannot be lost. Copies of the prints have been pasted into an album, each print receiving the same number as the cut, and, in the case of The Philippine Journal of Science, the number has been placed on the margin of the print in the bound set reserved for use in the library. They are now available when needed, although the work is not completed.

Reserve stock of The Philippine Journal of Science.—To protect against loss by fire, 36 complete sets of The Philippine Journal of Science have been placed in the library as a reserve stock.

Duplicates.—A large number of duplicates, many of which may be used to good advantage as exchange material, still remains on the shelves. "Want lists" and "duplicate lists" received are always examined carefully, and all duplicate material on hand and not needed is forwarded whenever there is opportunity. By this method, we have frequently filled in our own sets, receiving numbers lacking from our files in return for duplicates sent.

Exchanges and gifts.—A number of exchanges for the publications of the Bureau have been arranged, adding several valuable

publications; and several reports of commissions, series of government publications, etc. have been secured without cost.

Circulation.—The circulation of the library has increased steadily. All bound volumes out of the library were recharged once during the year, and single numbers of serials were checked three times. Calling in numbers to complete volumes for binding serves as a check against loss of single numbers, but it would be more satisfactory if the staff were sufficiently large to enable us to call in single numbers for renewal or discharge monthly and bound volumes at least twice a year. The total number of volumes charged during the year was 20,264, an average of 55.5 per day, including holidays and Sundays. The average per day for the fiscal year 1912 was 23. The total number of books out of the library on June 30, 1913, was 5,600. Many of these have been charged out since September, 1912, the time at which the recharging of all books out of the library was completed. No time limit has been placed on the circulation, and many of the above volumes are kept out practically all the time as deposits.

Use.—The use of the library has increased since the extension of the hours during which it is open and with more general information as to its resources. The recently completed installation of the lights in the stacks facilitates our work, and we are in a position to give a greater degree of publicity in regard to the library than we have heretofore found possible. There should be much greater growth during the next year. The tables will accommodate comfortably from twenty-five to thirty readers, and there is space in the reading room for another table to accommodate ten or twelve.

ENGINEERING DIVISION

There have been no changes in the direct supervision of the power plant or the responsible employees during the year, Mr. José Guerrero y Reyes remaining as chief engineer and Mr. F. R. Ycasiano as assistant engineer. Many of the subordinate employees have resigned and have been replaced by others.

The extension of the boiler room in front of the furnaces made possible the elongation of the fire box of, or more exactly the addition of a Dutch-oven furnace to, the new boiler and a convenient arrangement of auxiliary machinery and pumps in front of the boiler room, where there is good light, less dust, and better ventilation, conditions that help to reduce the depreciation of machinery.

Power plant.—This is the central power plant for the Philip-

pine General Hospital, the Bureau of Science, and the College of Medicine and Surgery, and supplies these institutions with electric current for operating incandescent and arc—including stereopticon—lights; fans; refrigerating machines for the city morgue, for the serum products, ice manufacture, and other purposes of the Bureau of Science, and for the food products of the Philippine General Hospital; air compressors; vacuum pumps; motors for driving the air and water ventilating and circulating systems, ore crushers, pulverizers and grinders, water pumps, gas scrubbers, centrifuges, and road materials testing apparatus; electric elevators; x-ray apparatus; radiographic apparatus; pantostat; cauterizers; radiometer; keratometer; ozonizers; electric furnaces and incubators; ultra-violet light sterilizing apparatus; liquid-air machine; electric enunciators; induction coils; ultra-violet photomicrographical apparatus; and charging electric ambulances, automobiles, storage batteries, etc.: steam for operating steam tables, urns, boilers and kettles, hot air baths, autoclaves, pumps, engines, automatic stills, hot water tanks, etc.: and gas for student and laboratory burners, gas stoves, gas engines, etc. The installation of the new 75-horsepower Babcock and Wilcox boiler has increased the boiler capacity to 225-horsepower, consisting of one battery of three 75-horsepower boilers.

The abatement of smoke has always been a serious problem when bituminous coal is used in boilers that are designed for high-grade coals. The device now in use in one of our boilers consists of the addition of a Dutch oven with a long furnace roof that attains an exceptionally high temperature, a large combustion chamber back of the bridge wall, and horizontal baffles which make a longer passage for the gases before reaching the comparatively low-temperature boiler tubes. This promises to be a satisfactory arrangement for the elimination of smoke. However, there are several problems that must be solved before pronouncing the device a complete success. The slope of the tubes of the Babcock and Wilcox boiler from front to rear is great, and the special bricks, put on and supported by the lowest row of tubes, slide from time to time, making short-cut passages for the gases which cause the emission of smoke. We shall try to prevent this sliding by using ring tiles which have the additional advantage of more perfectly preventing the early contact of the incompletely burned gases with the comparatively cold lowest row of boiler tubes.

The original construction of the Babcock and Wilcox boilers has vertical baffles with cleaning holes in one side of the wall.

With horizontal baffles, when the boiler is being fired, there is no easy means of removing the soot and dust which accumulate on top of them. In the Heine boilers the removal of the soot and dust from the top of the horizontal baffles is accomplished by special permanent steam connections from the tubes headers, and this arrangement is desirable and would be effective with our present boiler with its horizontal baffles.

At present, working plans are being prepared for the construction of Dutch-oven furnaces in front of the two boilers not yet so equipped.

With the installation of the producer-gas engine-driven dynamo, the total rated capacity of the electric generators in the engine room is 125 kilowatts. The most economical operation of any electric generating unit is to operate it at its rated capacity. This has been the aim in our power plant, and in order to get the most evenly distributed load the operating of the refrigerating machinery, the electrically driven feed pump, the electric motor-driven air compressor, and the charging of the electric automobiles of the Philippine General Hospital, respectively, are carried on at the most convenient time. The installation of the steam-driven air compressor makes our system more flexible. The steam-driven air compressor is used whenever there is high electric load, which one dynamo cannot carry, in addition to the electric motor-driven air compressor. This arrangement avoids the starting of another electric generating unit, which would call for the firing of another boiler, with consequent increase of operating expenses. If the load of the dynamo is not sufficient, then the electric air compressor is operated, which saves the steam which would otherwise be consumed by the relatively uneconomical steam air compressor. After office hours, the load on the dynamo usually falls off and the electric automobiles of the Philippine General Hospital are charged until 6.30 p. m., when the load commences to increase and is soon high due to the lights in the Hospital. If the arc-light reflectors in the surgical rooms are not needed, or there is no unusual load by 9.00 p. m., the charging of one electric automobile may be begun. At about 10.30 p. m. another electric automobile is connected, and until 7.30 a. m. the dynamo load consists of refrigerating machines, electric automobiles, a few lights, and the electrically driven boiler feed pump. The load distribution of the plant is almost ideal, except the two electric elevators of the Philippine General Hospital which cause peak loads. However, they are intermittent and last only a

few minutes, and are fairly well carried by the dynamo, although sometimes as overloads.

Producer-gas plant.—The new dynamo driven by the producer-gas engine is unquestionably far more economical in operating expenses than the generating steam units. Exact figures of the cost of the production of power for the producer-gas plant are being prepared, and they will be compared with that for the dynamos driven by steam engines. The producer-gas plant is operated from 7.30 a. m. to 11.30 p. m. In this way there is no restriction in the use of the electrically driven machinery and electric apparatus, and at the same time the boiler is relieved from overload, thus prolonging its life and reducing the depreciation and running expenses as well as reducing the production of smoke by light firing.

In estimating the advantages of the producer-gas engine over the steam engine in this plant, one must remember that we use the exhaust steam from the steam engine for heating to the boiling point about 10,740 cubic meters of ordinary city water per year for the Philippine General Hospital. When we run the gas engine we have to heat this same amount of water by live steam. We shall endeavor to devise a method of using the exhaust gases of the gas engine for heating the water for the Hospital, in order to effect greater economy.

Engine room.—The total electric current generated and delivered at the switchboard, from July, 1912, to May, 1913, is 214,650 kilowatt hours as compared with 179,192 kilowatt hours for the corresponding months of the last fiscal year; an increase of 16.56 per cent.

The total cost of 214,650 kilowatt hours is ₱21,741.25, which, expressed in unit cost, is ₱0.10129 per kilowatt hour against ₱0.10279 per kilowatt hour of last year; a reduction of 1.46 per cent in unit cost. Of the total current generated, 59.31 per cent was consumed in the Philippine General Hospital, 8.83 per cent in the College of Medicine and Surgery, and the remaining 31.86 per cent in the Bureau of Science.

Boiler room.—The total amount of steam generated in the boilers, for eleven months—from July, 1912, to May, 1913—is 11,042,120 kilograms as compared with 9,944,858 kilograms for the corresponding months of last year; an increase of 9.93 per cent. The total cost of generating the 11,042,120 kilograms of steam at 120 pounds per square inch, gauge pressure, is ₱28,126.49. Expressing these quantities in unit cost, it gives ₱0.0025472 per kilogram against ₱0.0026839 per kilogram of

last year; a decrease of 5.09 per cent. Of the total weight of steam generated, 38.71 per cent was used in the Philippine General Hospital, 0.09 in the College of Medicine and Surgery, 6.06 in the Bureau of Science, 3.67 in pumping the tunnel, and the remaining 51.47 was consumed by the steam engines to generate electric power.

Mansfield gas-generator plant.—The original room of the gas retorts is, at present, occupied by the producer-gas engine, and the retorts were moved to the new extension of the power plant. One more Mansfield generator has been installed, making a total of four units. The gas generated from the retorts is manufactured from kerosene and Cape lubricating oil. This gas is supplied to the Bureau of Science, the University of the Philippines, and the Philippine General Hospital. The total production from July, 1912, to May, 1913, amounted to 370,361 cubic feet (10,488.6 cubic meters).

In April I offered the by-product tar from the manufacture of gas to the Bureau of Health for the use of the mosquito brigade. It was found suitable for use in swampy areas, and since then 2 barrels weekly have been furnished for this purpose.

Shop.—The primary object of the shop is to set up and repair without delay the power-plant equipment and scientific apparatus of this Bureau. The building of an experimental lime kiln and other special apparatus, as well as erecting special apparatus such as the ultra-violet apparatus for the sterilization of water for the Bureau of Science, have been done in our shop. Two hundred sixty-nine jobs, the value of which is estimated at ₱3,000, were completed in the carpenter and machine shop. Besides routine work from the Bureau of Science, a number of jobs, consisting mostly of repairing, making and nickel-plating surgical instruments, making descriptive geometry models, photographic camera, and fishing spoons, have been completed mostly for the Philippine General Hospital and the University of the Philippines.

THE PHILIPPINE JOURNAL OF SCIENCE AND OTHER PUBLICATIONS

Nos. 4, 5, and 6 of volume VII and Nos. 1, 2, and 3 of volume VIII of The Philippine Journal of Science were published during the fiscal year. Beginning with No. 1 of volume VIII the designation of Section B was shortened from The Philippine Journal of Tropical Medicine to Tropical Medicine. The designations of Sections A, C, and D remain as in volume VII.

The following are the titles of the articles printed in The

Philippine Journal of Science during the fiscal year. Names of members of the Bureau of Science staff are marked by asterisks (*).

SECTION A. CHEMICAL AND GEOLOGICAL SCIENCES AND THE INDUSTRIES

Adams, George I. Timor Island; its supposed volcano and its probable tectonic relations.

* Agcaoili, Francisco. The composition of various milks and their adaptability for infant feeding.

* Cox, Alvin J. The oxidation and deterioration of coal.

———, * Reibling, W. C., and * Reyes, F. D. Sand-lime brick and artificial sandstones in the Philippines.

* Dovey, E. R. A new type of laboratory condenser for use with volatile liquids in tropical laboratories.

———. The composition of carabao's milk.

* Eddingfield, F. T. Alternation and enrichment in calcite-quartz-manganese gold deposits in the Philippine Islands.

———. Gogo, Entada scandens Bentham, and its effect on gold and gold solutions.

———. Ore deposits of the Philippine Islands.

* Fanning, Paul, R. A Philippine natural bridge.

———. Geological reconnaissance of northwestern Pangasinan.

———, and * Eddingfield, F. T. The black sands of Paracale.

* Gibbs, H. D., and * Agcaoili, F. Philippine citrus-fruits; their commercial possibilities and a chemical study of a few of the most important varieties.

——— ———. Some Filipino foods.

———, and * Pratt, D. S. The absorption spectra of ortho- and para-nitrophenol and para-nitrosophenol. New evidence of the quinoid structure of these compounds in alkaline solution.

——— ———. The mutual influence of hydroxyl and carboxyl and some related groups in the ortho position. A study of the absorption spectra of phenol, o-cresol, o-hydroxybenzyl alcohol, salicylic acid and its methyl ester, methyl ether of salicylic acid and its methyl ester, benzyl alcohol, benzyl acetate, benzyl methyl ether, benzyl chloride, and methyl benzoate.

———, * Williams, R. R., and Galajikian, A. S. Methyl salicylate IV. The saponification of methyl salicylate, methyl benzoate, and the methyl ether of methyl salicylate.

* Pratt, D. S. The optical efficiency of tinted glasses in relieving eye strain.

———, and * del Rosario, J. I. Philippine fruits: Their composition and characteristics.

———, and * Gibbs, H. D. The absorption spectra of phenoquinone, 2, 5-dianilinoquinone, 2, 5-dianilinoquinoneanil, and 2, 5-dianilinoquinonedianil (azophenine).

——— ———. The two phthaloximes: A study of their absorption spectra and constitution.

* Reibling, W. C. A bonus system for the purchase of Portland cement.

Tempongko, Clodoaldo. Sugar-cane experiments.

* Thurlow, L. W., and * Pratt, D. S. Extraction test of a modern sugar central.

SECTION B. THE PHILIPPINE JOURNAL OF TROPICAL MEDICINE, VOLUME VII, NOS. 4, 5, AND 6; SECTION B. TROPICAL MEDICINE, VOLUME VIII, NOS. 1, 2, AND 3

Ashburn, P. M., Vedder, E. B., and Gentry, E. R. The relationship of variola and vaccinia.

* Barber, M. A. The susceptibility of cockroaches to plague bacilli inoculated into the body cavity.

Boynton, William Hutchins. A note upon strangles in the Philippine Islands.

———. A study of the normal blood of the carabao.

———. Notes on the muscular changes brought about by intermuscular injection of calves with the virus of contagious pleuropneumonia.

Butler, C. S. Some carbohydrate reactions of the dysentery bacillus.

* Crowell, B. C. Status thymico-lymphaticus among Filipinos.

———, and Hammack, R. W. Intestinal parasites encountered in five hundred autopsies, with reports of cases.

Fox, Carroll. The plague outbreak in Iloilo.

Gilman, P. K. Appendicitis.

———. Axillary teratoma.

———, and * Crowell, B. C. Report of the pathological examinations for one year from the surgical clinic of the Philippine General Hospital.

Hammack, R. W. Primary sarcoma of the small intestine.

Heiser, Victor G. The outbreak of plague in Manila during 1912. The insidious beginning, with a discussion of probable factors concerned in its introduction.

Hilario, José S. Tumors of the pituitary gland. Report of a case of pituitary glioma.

Mitzmain, M. Bruin. The biology of Tabanus striatus Fabricus, the horsefly of the Philippines.

———. The bionomics of Stomoxys calcitrans Linnæus; a preliminary account.

———. The mechanical transmission of surra by Tabanus striatus Fabricus.

———. The rôle of Stomoxys calcitrans in the transmission of Trypanosoma evansi.

Musgrave, W. E., and Sison, A. G. The bone lesions of smallpox. Second report.

* Ruediger, E. H. The duration of passive immunity against tetanus toxin.

* Strong, Richard P., and * Crowell, B. C. The etiology of beriberi.

Teague, Oscar. A further note upon the influence of atmospheric temperature upon the spread of pneumonic plague.

Vedder, Edward B. A fourth contribution to the etiology of beriberi.

———, and Clark, Elbert. A study of polyneuritis gallinarum. A fifth contribution to the etiology of beriberi.

———, and * Williams, Robert R. Concerning the beriberi-preventing substances or vitamines contained in rice polishings. A sixth contribution to the etiology of beriberi.

* Walker, Ernest Linwood. Quantitative determination of the balantidicidal activity of certain drugs and chemicals as a basis for treatment of infections with Balantidium coli.

* Willets, David G. General conditions affecting the public health and diseases prevalent in the Batanes Islands, P. I.

———, and * Schöbl, Otto. Isolation of Diplococcus intracellularis meningitidis Weichselbaum from a case of cerebrospinal meningitis occurring in a native of the Philippine Islands.

The Philippine Islands Medical Association. Minutes of the Ninth Annual Meeting.

SECTION C. BOTANY

Brotherus, V. F. Contributions to the bryological flora of the Philippines, IV.

* Brown, W. H. The relation of Rafflesia manillana to its host.

———. The relation of the substratum to the growth of Elodea.

———, and * Graff, P. W. Factors influencing fungus succession on dung cultures.

Copeland, Edwin Bingham. Notes on some Javan ferns.

———. On Phyllitis in Malaya and the supposed genera Diplora and Triphlebia.

Diels, L. Three new species of Menispermaceae.

Hubbard, F. Tracy. On Eragrostis cilianensis (All.) Vignolo lutati.

Kränzlin, F. Cyrtandraceae novae philippinenses, I.

* Merrill, E. D. New or noteworthy Philippine plants, IX.

———. Nomenclatural and systematic notes on the flora of Manila.

———. Notes on Philippine Euphorbiaceae.

———. On the identity of Evodia triphylla DC.

———. Studies on Philippine Rubiaceae, I.

———. The Pineda monument and the probable site of the first botanic garden in the Philippines.

Rehm, H. Ascomycetes philippinenses collecti a clar. C. F. Baker.

* Robinson, C. B. Roxburgh's Hortus Bengalensis.

Sydow, H. and P. Descriptions of some new Philippine fungi.

Wainio, E. A. Lichenes insularum philippinarum, II.

Warnstorf, C. Die Sphagna der Philippinen.

SECTION D. GENERAL BIOLOGY, ETHNOLOGY, AND ANTHROPOLOGY

Baker, C. F. A study of caprification in Ficus nota.

Bernhauer, Max. Neue Staphyliniden der Philippinen.

* Beyer, H. Otley. Origin myths among the mountain peoples of the Philippines.

Borchmann, Fritz. Lagriiden und Alleculiden der Philippinen (Coleoptera).

* Christie, Emerson Brewer. Notes on the woodworking industry of San Vicente, Ilokos Sur.

———. The stone industry at San Esteban, Ilokos Sur.

Cowles, R. P. The habits of some tropical crustacea.

Heller, K. M. Neue Käfer von den Philippinen.

———. Philippinische Rüsselkäfer.

* Jones, Charles R. The cigarette beetle (Lasioderma serricorne Fabr.) in the Philippine Islands.

———. The coconut leaf-miner beetle, Promecotheca cumingii Baly.

Ohaus, Fr. Nachträge und Berichtigungen zu: "Die Ruteliden der Philippinischen Inseln."

Oshima, Masamitsu. Description of a new gecko from Botel Tobago Island.

Salt, Alexander E. W. Francisco de Carriedo y Peredo.
* Seale, Alvin. Description of a new Acanthocybium from the Philippine Islands.
———. Notes on Philippine edible mollusks.
———. Some poisonous Philippine fishes.
Weise, J. Über Chrysomeliden und Coccinelliden der Philippinen: III Teil (Coleoptera).

The amount and variety of material available for publication has increased during the year. A part of this is secured through an arrangement with the Bureau of Agriculture whereby such technical papers from the Alabang laboratory as are desirable are published in Section B of The Philippine Journal of Science. The United States Army Board for the Study of Tropical Diseases as they Exist in the Philippine Islands, the University of the Philippines, and the Bureau of Health, as heretofore, offer material on subjects pertaining to medical sciences or to zoölogy.

Much effort has been expended toward obtaining prompt issue of the Journal numbers. Some improvements over the condition of last year have been made. The most extensive single publication issued during the year was A Flora of Manila, 490 pages, Bureau of Science Publication No. 5. This work treats in manual form somewhat over 1,000 species, with descriptions of, and keys to, families, genera, and species, and other data. It is the most generally useful botanical publication yet issued by the Bureau. The publication is of especial value to teachers and students of botany and biology, as it gives, in compact form, means of determining most of the common plants found in and about towns in the Philippines. Of minor importance are the new edition of the Catalogue of Plants Cultivated in the City Nursery at the Cementerio del Norte, issued early in the year by the city of Manila and an article on Philippine Shade Trees and Ornamental Plants prepared at the request of the Director of Public Works and published in the Quarterly Bulletin of the Bureau of Public Works. Both publications were prepared to stimulate official and private interest in the matter of planting and care of ornamental trees and plants. A short article on sugar, The Financial Loss Occasioned by Harvesting Unripe Sugar Cane, by D. S. Pratt and L. W. Thurlow, was contributed to the Philippine Agricultural Review.

Some effort is being made to unify the style of the numerous blank forms and labels used in the Bureau. While the matter of uniformity should not be too rigorously insisted upon, it seems

worth while to strive for greater similarity of type and headings than has existed.

The stock of the "Publications" folder issued in 1911 was exhausted. As the old folder has been found to be convenient and effective, the same make-up with the necessary additions has been used for a new edition.

The Bureau of Science Press Bulletins, which heretofore have been used exclusively for material from the division of mines of this Bureau, were made more general in character, and will in the future include information of a suitable character from any division of the Bureau.

Two years ago the mailing list of the Journal comprised 722 names and last year 855. It was our desire to make it an even thousand at the end of the present fiscal year, and we are only three short of that number, an increase over last year of 142 names, of which 106 were paid subscriptions. Of the 997 names on the mailing list, 447 are "paid" subscriptions, 427 are exchanges, 74 are for review, and 49 are free copies. The increase in paid subscriptions during the year has been 30 per cent as against an increase of between 20 and 25 per cent for last year.

The matter of keeping the Journal and publications accounts paid up is one of considerable difficulty, but each year seems to show better results. In every instance our outstanding accounts are less than they were at the end of the last fiscal year, and at the same time more Journals and publications have been sold. The total receipts from the Journal and other publications have been ₱6,021.09, or ₱1,272.57 more than for the last fiscal year. The fact that our outstanding accounts are at present less than those at the end of the last fiscal year will reduce this gain somewhat. It is estimated that the cost of printing the Journal and reprints therefrom for free distribution to contributors has been ₱23,407.48 for the present year as against ₱17,918.15 for the previous year. However, the very large number of plates and great number of pages in the plague number of Section B, the memorial number, and other unusual expenses have tended to add to the total cost of printing.

The value of the general publications of the Bureau of Science sold is ₱1,807.57, or ₱84.05 more than for the previous fiscal year, but ₱496.10 less than in 1911, owing largely to the fact that The Bontoc Igorot by A. E. Jenks and No. 8 of Volume I of the Journal which contained an article on the Non-Christian Tribes of Northern Luzon by the Honorable Dean C. Worcester

were exhausted last year and nothing has yet been published to take their place. Either of these articles, if revised and reprinted, would find a ready sale. It was anticipated that the Manual of Silk Culture would find a ready sale, but it has not done so.

There have been no new agents designated during the past year. Some of our present agents do not seem as active in the interest of the Journal and our general publications as they should be. It is probable that a large number of sales could be effected in the United States if we could secure active and responsible agents in some half dozen of the larger cities of the country.

During the year about 2,000 personal letters were sent out. In each of these was inclosed one of our publication folders. Without doubt the increase in paid subscriptions was largely due to these letters, and they will probably be productive of results for another year or two. We have also mailed several thousands of our new publication folders. Our personal letters and publication folders have been pretty well distributed over America, and have gone to most scientists and scientific institutions of reputation, so that possible results may be obtained in that way. There are still many new and untried ways of advertising the Journal, and one may be discovered which will be successful in attracting the class of people to be interested. This has been a successful year for the Journal, and the coming year should also be productive of returns from advertising done during the two previous years.

The attic is used as a place to store the Journal and other publications as well as for the preparation of those for mailing. This is the only available place. It is very unsatisfactory and undesirable from many standpoints, especially on account of the weight of the publications, the danger of fire, and the control of employees working there.

CLERICAL DIVISION

Personnel.—Mr. A. E. Southard, chief clerk, cashier, and disbursing officer, was absent on leave from the Islands more than one-half of the present fiscal year, during which time his work was very satisfactorily performed by Mr. C. J. Stancliff. Mr. Stancliff has now resumed his duties as property clerk. Since January Miss Celesta Cromer has been on leave in Europe and the United States. Mrs. Dora Chapman has been employed temporarily as a stenographer in her place. Mrs. M. E. Brown,

who has been an employee of this Bureau for more than two years, resigned in January on account of ill health, and her position has been very satisfactorily filled by Mrs. M. Davis. Mr. G. M. de Ubago, who was assistant and acting property clerk, resigned, effective June 15, 1913. Mr. Ubago has been a member of the Bureau since its organization and by reason of his length of service and more than ordinary ability was a very valuable and efficient clerk. Our Filipina stenographer and typist who, a year ago, showed promise of becoming a very competent clerk has continued to progress and is now in charge of the correspondence and accounting connected with The Philippine Journal of Science. Much economy can be practiced if really competent Filipino clerks can be secured to do work which it formerly was thought absolutely necessary to have done by Americans.

Filing.—This work has not progressed very rapidly nor as satisfactorily as seemed possible. It was expected that it would take three or four months, but already a year has elapsed and the work is not yet completed. However, our records are more accessible than they were twelve months ago. Filing is one of the most difficult and important parts of any office work, and much of our former difficulty in keeping our records readily accessible has been due to the underestimated importance of the work and in leaving it to the less competent clerks. There are at present two very hard-working Filipino clerks engaged with the records, and, with the work well started, by steady application they will be able to keep up with the current work and bring the indexing of the older records to completion.

The two bicycles purchased two years ago have given excellent service and have unquestionably saved much more than their cost in car fare and carromata hire, besides giving us a system of quick messenger service otherwise unobtainable. They have had hard wear and will soon need to be replaced.

The new filing cabinets for the index cards to the files received a few months ago are satisfactory, and are now in use.

The purchase and installation of a watchman's time clock with keys distributed about the buildings and premises insures the watchman visiting all parts of the buildings and grounds a number of times each night and adds to his efficiency.

Our telephone service seems much improved since it has been taken over by the Executive Bureau. Trained and competent operators are furnished at a very reasonable salary. The service of late has been somewhat annoying owing principally to de-

fective and worn-out equipment. I have been informed that a new telephone switchboard for this Bureau is being made and will soon be installed.

The dissension and general dissatisfaction relative to the compensation of the muchachos which were noticeable before the adoption of the present rules and regulations governing that matter seem entirely to have disappeared. The rules adopted about a year and a half ago work almost automatically and are very satisfactory.

Transportation facilities for official use of members of the Bureau seem adequate and satisfactory. Any member of the Bureau desiring transportation can almost always have it within an hour from the time of making his request. A small automobile runabout to be operated by the man using it would be very desirable, and could probably take the place of the carromata.

1914 PHILIPPINE EXPOSITION AND 1915 PANAMA-PACIFIC INTERNATIONAL EXPOSITION

Many of the lines of work of the Bureau of Science cannot well be exhibited, but some of our collections and our industrial investigations are of exceptional popular interest. Demonstrations of the industrial operations of mining, fisheries, and silk culture and the products made from Filipino raw materials, such as paper, sand-lime bricks, tiles, vitrified bricks, cement, and artificial marbles, could be shown. Exhibits of Philippine coal; nipa and its products—such as alcoholic beverages and nipa sugar—products of coconuts, oranges, and other fruits; tan bark; cutch; rocks and minerals; corals; fossils; shells; a representative herbarium; fishing outfits; birds and other natural history specimens; as well as a wonderful display of colored transparencies and photographs could be made if funds were available. Models showing the mineral districts, underground workings in mines, the gold production by year, native iron smelters, pottery works, a modern sugar central, and photographs showing the working of various dredges and mills could be made for a small sum. Probably the most acceptable and popular exhibit in the Panama-Pacific Exposition would be collections from the Christian and non-Christian tribes, consisting of a representative exhibit from each tribe. I have outlined an exhibit for the chairman of the 1915 Panama-Pacific International Exposition which could be delivered in Manila for ₱40,000. This can be made smaller if desirable, and there is a great deal which could be done for a local exhibit that would require practically no funds; however, two or three thousand

pesos should be available for making models of modern sugar centrals and other instructive industrial operations, in order that the knowledge of the Bureau of Science should be properly disseminated and serve its greatest usefulness.

THE AQUARIUM

In the early part of the year it was decided that 1-inch glass be ordered to replace the thinner glass in the aquarium, as the latter has a factor of safety of less than two, and that rigid iron frames with planed surfaces be constructed for the heavy glass. The iron frames have been completed and installed, and the 1-inch glass ordered from the United States has arrived and has been put in place. The design of the iron frames is such that certain parts are protected from the salt water in the aquaria only by a preservative coating, and I fear that this will be insufficient to prevent discoloration of the water due to corrosion of the iron. The Kinney pump for the circulating system also has been installed, and several other minor changes have been made to facilitate the operation of the aquarium. There yet remain to be accomplished the construction of a roof over the shark tank, the concrete garden seats and railings along the promenade over the aquarium tunnel, the completion of the gates to the crocodile tank, and a few minor details. The Bureau of Public Works will complete these as soon as possible. If the iron frames do not corrode, the system will be in readiness to receive such material as the ichthyologist, who is now accompanying the Honorable the Secretary of the Interior on an inspection trip around the eastern coast of Luzon, may bring back with him. A collecting trip, especially to secure material, will be made as soon as the aquarium is ready to receive it and the aquarium then can be opened to the public. The delay in the arrival of the glass has given a year for the grass and vines to grow, so that the aquarium grounds are now beautifully parked.

It is necessary to provide for the operation and maintenance of the aquarium; an admission fee will be charged, the proceeds to go toward its support. The life of aquarium material averages only a few months, so that the cost of frequent expensive collecting trips will have to be borne in addition to the salaries and wages of the employees at the aquarium. The Bureau will need to be guaranteed against a deficit in the operation of the aquarium not covered by receipts, and it is requested that ₱5,000 be added to the annual appropriation of the Bureau of Science for this purpose.

RECOMMENDATIONS

It has been four years since this Bureau has had an increase in appropriation, in spite of the fact that the demands made upon it have increased in every direction and the work has continued to grow at a steady and almost amazing rate as shown by the foregoing report and those of the two previous years. Each year new lines of work have been undertaken and other additions shown to be desirable. The Bureau must continue to develop and add new phases of the work as the country grows and as the desire for accurate study and information concerning the conditions which surround us is extended. However, such new phases cannot be added and developed in their greatest efficiency without funds to maintain the expansion.

This Bureau has enjoyed the confidence of other branches of the Government and the public, and there has been a constantly growing desire to consult our scientists on theoretical and practical matters and problems pertaining to mining, commercial and industrial enterprises, and health. Frequently, we are able to supply the information desired simply by reference to our publications, but in some cases we are unable to assist because of insufficient staff and apparatus. Last year my report showed an increase of 45 per cent for the year in the number of routine biological examinations; an increase of 49 per cent in routine samples of rocks and minerals, soils, fertilizers, cements, clays, metals and alloys, road materials, stone, gravel, sand, concrete, water, coal, standardization of weights and measures, etc.; and an increase of 29 per cent over the previous fiscal year in the number of analyses of meat and meat products, fish and fish products, milk, butter, cheese and other dairy products, canned vegetables, flour, infants' food, tea, coffee, sugar, jam, jelly, marmalade, vegetable oils, essences, beverages, etc. There has been a further corresponding increase in all branches of the Bureau work during the fiscal year which shows how the work of the Bureau of Science has grown without an increase in the allotment of funds.

The work of maintaining in a constantly growing bureau what is in effect a department of information has seriously encroached upon our research and handicapped us in carrying on new lines of investigation as well as completing those already begun. Formerly, there were unfilled authorized civil service positions in this Bureau which made the system flexible. At the present time, practically every position is filled and we carry as many temporary employees as we can afford. We are in the greatest need of more scientific employees and laboratory space

and equipment to handle the additional work which devolves upon us on account of the growth of the laboratory.

The expansion of the Bureau has also brought with it the necessity of a greater expenditure for clerical work. On account of the increase in the size of the library, an additional technical worker, with good technical training and considerable experience, is very much needed to keep the work up to the required standard. A large amount of work is done in the library for the University of the Philippines, and it would not be an unfair arrangement for the university to pay to this Bureau an amount equivalent to the salary of one additional trained librarian in case such an employee cannot be provided for by direct appropriation. Also, as stated in my last annual report, a draftsman is needed to make ornithological, botanical, and entomological drawings and to mark copy for illustrations for The Philippine Journal of Science and other publications. A man for this purpose would have his time fully occupied.

New testing laboratory.—As was pointed out in my last annual report, the congested condition in our cement-testing laboratory which was originally arranged for 5 employees and in which we now have 17 working, is serious. Demands are more and more frequently being made upon the Bureau of Science to conduct researches in engineering for the benefit of the public. The testing of building materials cannot stop with that of cement alone; it must include many important adjuncts, and adequately to provide for such work additional machinery, quarters, and probably additional employees will be needed. We should at the present time be equipped thoroughly to test mechanical and electrical apparatus as well as ordinary construction and other materials such as we now undertake. Act 2264, section 3-c of the Third Philippine Legislature, special session of 1913, appropriated ₱50,000 subject to the release of the Governor-General for a testing laboratory building. I have requested the authorization of the release of these funds, and assume that the testing laboratory is assured.

Additional room needed.—Two years ago the east wing of the laboratory building was first occupied by the library, the sections of fisheries and of ornithology, the entomological collections and laboratories, and the division of mines. It was thought at that time that those branches would be accommodated for several years to come. The central scientific library of the Government, which is the scientific branch of The Philippine Library, is housed in the Bureau of Science. The library has been added to by the various colleges of the University of the Philippines and by other

branches of the Government. The available space has rapidly been filled, and even now certain sections are crowded. Frequent moving of large sections of books in order to shelve new sets is far from economical, and as the limit of the capacity of the library is approached such changes become necessary at more and more frequent intervals, since it is impossible to predict with certainty what sections will grow most rapidly. More room and additional shelf space for the care of the scientific books will be urgently needed before they can be provided.

We have in the Bureau of Science the best collection of Philippine plants in the world. The scientific value of this botanical collection cannot be estimated, for it would be impossible to replace the larger portion of it, but there is no doubt that the herbarium has an immediate cash value of ₱30,000. In its present location the herbarium is in danger of destruction by fire. Plans for safer housing of the collections in a fire-proof building should be made. The present quarters give very little light, now that they are stored full of herbarium cases and are not at all adapted to the needs of a herbarium.

The present arrangement of the clerical force is very unsatisfactory. The office of the chief clerk is on the first floor; the majority of clerks are housed in a large room over the serum laboratory; the assistant to the editor of The Philippine Journal of Science and the clerks that have to do with the Journal and other publications are on the second floor, and the clerks who wrap and mail the publications are in the attic. This is a very unsatisfactory arrangement. The clerks who wrap the publications of the Journal should be under the direct supervision of the assistant to the editor. All clerks should be segregated so that they may be easily supervised, and all of these various branches should be near the office of the director of the Bureau. The large room at present occupied by the herbarium is not at all well adapted to the needs of the botanists, but it would make an admirable general office in which could be placed the entire clerical force, including the proof readers and others connected with The Philippine Journal of Science and other publications. This centralization would result in better discipline, greater efficiency, and the saving of much time.

I have the honor to recommend the appropriation of ₱50,000 to complete the new wing for which one-half has already been provided in Act 2264 of the Third Philippine Legislature, special session of 1913, in order that we may provide for a fire-proof building in which to house the valuable botanical collections

and in order to provide room to which we can transfer other branches of the work now occupying the new wing of the Bureau and which in turn would provide suitable expansion for the library. The herbarium is rapidly increasing in size, and would require at least one-half of the additional building requested.

Water survey.—For several years this Bureau has had at least one chemist engaged in making water analyses, of which up to the present time we have performed over one thousand from artesian wells, dug wells, reservoirs, springs, rivers, etc. In spite of this, our knowledge of the quality and quantity of available Philippine water supplies is extremely limited. Considerable misconception exists concerning the value of results obtained from the ordinary sanitary, mineral, and bacteriological analyses of water. It is commonly supposed that such examinations may be interpreted in the same manner as other analyses, for instance, as the analyses of iron ore. However, as a matter of fact the bacterial count of water has little significance after a sample has been drawn for an hour or two without being kept on ice, and sanitary and mineral analyses of water should be considered more in the nature of a series of experiments than as giving results from which one may make a direct interpretation of the potability or medicinal value of the water. All classes of water analyses simply assist us to judge the character of the water. Without an accurate knowledge of the normal constituents of the source, the conditions under which the sample was taken, and the other factors which influence it, it is impossible to pass judgment upon a water. An investigation and study of all medicinal and thermal springs in the Islands should be undertaken, and a reservation as a public domain of a suitable area surrounding those of value should be made. It seems to me that it is a duty the Government owes to future generations to provide an adequate water survey at the present time. When funds are available, an appropriation should be made to this Bureau for carrying on a careful survey of Philippine water supplies.

Iloilo sugar laboratory.—The continued drought of 1912 delayed the planting of sugar cane to such an extent that when it was begun the season was already far advanced. Many of the earlier seeded fields did not sprout at all and had to be replanted; during the following rainy season two typhoons swept the Visayan Islands in swift succession, and the same region was next visited by a swarm of destructive locusts. At the beginning of the season the prospects were unfavorable, and this combination of misfortunes practically destroyed many crops. Furthermore,

due to the large European beet-sugar crop and the largest crop of cane sugar ever grown in Cuba, very low prices have prevailed, and there has been very little demand for Philippine sugar on the markets of the United States. One trial shipment of 4,115,704 kilograms was made early in the season as against 176,195,210 kilograms last year. The Formosan crop was almost an entire failure, and for this reason middle and lower class Philippine sugars have been in demand in the markets of China and Japan and have brought very good prices. The first shipments for the fiscal year 1913 have been 90,256,845 kilograms as against 27,075,031 kilograms for the fiscal year 1912. Nos. 1 and 2 sugars have had few buyers.

The sudden change of market has had a marked effect on our laboratory work. When sugar was shipped to the United States sales were made on a polariscopic basis. This year the Chinese dealers often have paid more for sugar simply on the color and feel than its polarization warranted. This, as well as the short crop, has affected the number of samples received. In spite of all these circumstances, the total number of samples received and polarized in Iloilo during the past fiscal year is 3,155, only 50 samples less than the number for the previous fiscal year, which shows that the laboratory has greatly grown in the estimation of the planters and dealers.

Two central sugar mills have been started in the Visayan Islands during the past year. They have a rated capacity of 15 tons of sugar in twenty-four hours each, but neither has ever been able to obtain the rated capacity. However, both mills have been highly successful when compared with the former crude methods of extraction. These two mills have been so successful that plans have been made to have 7 central mills in operation next season. In spite of their apparent success, the local central mills are doing very poor work with poor operation. They are vastly better than the native process, but one cannot help but regret the loss which might be converted into a profit. The hacenderos are accustomed to cheap labor. It is hard for them to realize the advantage of paying a high-class man several hundreds of pesos a month to operate the mill. In many cases such a man will save his entire month's salary in a single day. Our expert assisted in a test at one mill in order to demonstrate the loss, and it was shown that, if the lost sugar be figured at 28.5 centavos a kilogram, the daily loss was ₱440. A sugar central mill no matter how small must be chemically controlled.

Where it has not been feasible to erect central mills, the centrifugal alone has been used to good advantage as a means of

improving the grade of native sugar. The cane is milled and defecated in the usual manner, and the evaporation continued in the open cauas until a striking point at a temperature of 111° C. is reached, when it is ladled into graining tanks and allowed to cool and crystallize. After crystallization, the massecuite is removed to the centrifugal, where it is purged without washing and yields a sugar having a sucrose content of from 93 to 95 per cent. The sugar is soft, and the color is dark as no water is used, but the slight improvement in color by washing would not compensate for the sugar washed away in an attempted improvement.

Our records show that last year the purity of the cane attained a maximum very early in the season, probably due to the lack of rain which stopped the growth and induced ripening. Later in the season the grade of the sugar was lower, which indicates that the cane became overripe. This year, however, the purity increased regularly until January before it began to decline, indicating overripeness. It is noteworthy that the average purity for this year is 2 per cent less than for last, which indicates that a greater amount of green cane was cut with the consequent loss to the planter.

We have carried on some experimentation and research with cane from La Granja station of the Bureau of Agriculture at La Carlota. What we have been able to do is merely a beginning. In my last report I indicated the desirability of obtaining a piece of land in or near Iloilo where the cane can be more closely watched and the work carried out to better advantage. Never before has it been more desirable to have funds for the establishment, equipment, and maintenance of a suitable experimental farm. Experimental work carried on in Iloilo should materially assist the grower throughout the Archipelago and in the development of the sugar-cane industry of the Philippine Islands.

I have given this account in order to show that, in addition to our laboratory work of polarizing sugars, there is a large amount of instruction work with regard to the planting and harvesting of cane, as well as to the perfect recovery of the sugar which should be given to the planters. Thousands of pesos could be saved annually to the sugar grower if he were familiar with the precautions which he should take. Attention has already been called to the desirability of creating a sugar division in this Bureau consisting of at least three men. With such a corps of workers, there would be time to do field work and give instruction which would forestall the extravagant practices now in vogue among some of the sugar planters. This year a press

bulletin has been issued on The Financial Loss Occasioned by Harvesting Unripe Sugar Cane. It is especially recommended that funds be appropriated to this Bureau to enable us to carry on work among the sugar planters as indicated.

There is need for a model central sugar mill at Iloilo. Iloilo is the center of the sugar industry, and sugar men from many provinces trade there. More hacenderos could be reached here than at any other place. There are many central mills of the smaller type being erected throughout the country, and their owners are absolutely ignorant regarding mills and their control. There is sufficient cane grown in the vicinity of Iloilo to operate a 15-ton central mill during the season, and it could very profitably operate in remelting and reboiling low-grade sugars in the idle season, so that no shut down would be necessary and it would be entirely self-supporting. Such an institution would serve as a training school for mill operators. If funds are available, no better investment could be made by the Government than to build and operate such a mill and to use it in showing the people how to save the many thousands of pesos that are being wasted daily because of inexperience and lack of knowledge.

Coöperative work.—The Bureau of Science has continued to assist the College of Medicine and Surgery and the College of Liberal Arts of the University of the Philippines by detailing some of its best men to give instruction in chemistry, botany, tropical medicine, medical zoölogy and parasitology, pathology and bacteriology, immunity and serum therapy, disinfection and disinfectants, and medical entomology. We have been glad to do this because it has given to the students of the University not only good instructors, but contact with men engaged in active practical work. The more minute record of the detail of these men has already been given in discussing the work of the various branches of the Bureau. Last year I called attention to the belief by some that men are more rapidly advanced in the University than in the Bureau of Science, and that there should be no discrimination between these institutions of the Government and that the appropriation for salaries and wages for the Bureau of Science should be just as liberal as in any of the others. I desire to repeat my recommendation that an appropriation of ₱30,000 be added to that of the Bureau of Science in order that parallel salaries may be maintained between this institution and other branches of the Government.

Former recommendations.—Since no current appropriation bill has been passed for the last three years, no action has been

taken on my previous recommendations with regard to funds for the investigation of animal diseases and insects injurious to agricultural products, the purchase of books necessary to complete sets now in the central scientific library, reissuing exhausted editions of certain publications, or enlarging the scope of our present work on the fish and fisheries of the Philippine Islands. The wisdom of providing funds for this work is as evident as heretofore, and I heartily recommend that appropriations for these purposes be made when funds are available.

Tables showing the routine work performed and supplies manufactured and disposed of during the fiscal year 1912–13 by the Bureau, and a financial statement showing the appropriation and how it was expended, are attached hereto.

ALVIN J. COX,
Acting Director, Bureau of Science.

To the Honorable,
The SECRETARY OF THE INTERIOR.

TABLE I.—*Comparative table of routine work performed and supplies manufactured and disposed of during the fiscal year 1913, as compared with the fiscal year 1912, by number or quantity.*

[July 1, 1913.]

Division of the Bureau.	Samples or units.		Decrease.	Increase.
	1912	1913		
General, inorganic, and physical chemistry:				
Metals and alloys	36	45		9
Rocks, minerals, natural pigments, and similar substances	46	15	31	
Clays, shales, limestones, limes, wall plasters, cements, and slags	83	55	28	
Fertilizers	16	10	6	
Soils and similar substances	61	14	47	
Coal analyses	20	58		38
Steaming tests	2		2	
Calorimetric tests of fuels	8	42		34
Waters	146	187		41
Crude chemical and miscellaneous analyses	33	35		2
Standard solutions	33	10	23	
Physical tests of wire, twine, fibers, textiles, paper, and similar articles	14	48		34
Cements	8,476	9,535		1,059
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	221	54	167	
Standardization of road materials	27	62		35
Standardization of units of measure—				
Lengths		96		96
Capacities	370	154	216	
Weights	620	667		47
Miscellaneous	156	210		54
Total	10,368	11,297		929
Organic chemistry:				
Urines, clinical and toxicological analyses	[a] 6,143	2,666	3,477	
Essential oils and essences	6	37		31
Petroleum and products, copra, and similar materials	17	71		54
Paints, varnishes, and linseed oils	41	46		5
Gums, resins, and similar materials	1	3		2
Paper and similar materials	126	107	19	
Gastric juice, clinical examinations	7	12		5
Foods, alcohols, and beverages	1,288	1,035	253	
Food preservatives and coloring matters	32	19	13	
Medicines and similar articles	84	232		148
Miscellaneous	91	77	14	
Total	7,836	4,305	3,531	

[a] Includes all urines examined by the biological laboratory.

TABLE I.—*Comparative table of routine work, etc.*—Continued.

Division of the Bureau.	Samples or units.		Decrease.	Increase.
	1912	1913		
Mines: Assays	413	288	125	
Biological laboratory:				
Fæces	21,684	34,530		12,846
Sputum	3,861	5,770		1,909
Blood	2,976	25,539		22,563
Urine	(a)	6,974		6,974
Gonococci	15,971	20,522		4,551
Waters	742	1,077		335
Necropsies	54	87		33
Miscellaneous	3,482	57,972		54,490
Total	48,770	152,471		103,701
Serum section of the biological laboratory:				
Vaccine virus (doses)—				
Prepared	2,148,186	2,237,672		89,486
Disposed of	2,107,359	2,419,723		312,364
Antirinderpest serum (cubic centimeters)—				
Prepared		27		27
Disposed of	694,666	417	694,249	
Plague prophylactic (cubic centimeters)—				
Prepared		3,660		3,660
Disposed of		330		330
Mallein (doses)—				
Prepared	532	512	20	
Disposed of	641	280	361	
Diphtheria antitoxin (units)—				
Prepared	639,000	983,000		344,000
Disposed of	475,500	830,500		355,000
Tetanus antitoxin (units)—				
Prepared	1,821,700	1,406,500	415,200	
Disposed of	894,500	1,986,000		1,091,500
Cholera prophylactic (cubic centimeters)—				
Prepared				
Disposed of				
Antiplague serum (cubic centimeters)—				
Prepared	60	9,540		9,480
Disposed of	60	9,240		9,180
Anticholera serum (cubic centimeters)—				
Prepared				
Disposed of		2		2
Antidysentery serum (cubic centimeters)—				
Prepared	1,950	2,280		330
Disposed of	780	3,130		2,350

[a] Included under organic chemistry.

TABLE I.—*Comparative table of routine work, etc.*—Continued.

Division of the Bureau.	Samples or units.		Decrease.	Increase.
	1912	1913		
Serum section of the biological laboratory—Continued.				
Antityphoid serum (cubic centimeters)—				
Prepared	52	3,000		2,948
Disposed of	1	30		29
Tuberculin, human (cubic centimeters)—				
Prepared	575	26	549	
Disposed of	328	326	2	
Tuberculin, bovine (cubic centimeters)—				
Prepared	224	50	174	
Disposed of	61	184		123
Antigonococcus prophylactic (cubic centimeters)—				
Prepared				
Disposed of				
Antistaphylococcus aureus and albus (cubic centimeters)—				
Prepared		622		622
Disposed of		450		450
Normal horse serum (cubic centimeters)—				
Prepared	25,160	20,580	4,580	
Disposed of	990	1,950		960
Normal salt solution (liters)—				
Prepared				
Disposed of	2		2	
Typhoid vaccine (cubic centimeters)—				
Prepared		1,760		1,760
Disposed of		422		422
Tuberculin vaccine (cubic centimeters)—				
Prepared				
Disposed of				
"A" serum for exopthalmic goitre (cubic centimeters)—				
Prepared				
Disposed of				
"B" serum for exopthalmic goitre (cubic centimeters)—				
Prepared				
Disposed of				
Rabies vaccine (doses)—				
Prepared				
Disposed of				
Anthrax vaccine No. I (cubic centimeters)—				
Prepared				
Disposed of				

TABLE I.—*Comparative table of routine work, etc.*—Continued.

Division of the Bureau.	Samples or units.		Decrease.	Increase.
	1912	1913		
Serum section of the biological laboratory—Continued.				
Anthrax vaccine No. II (cubic centimeters)—				
Prepared				
Disposed of				
Staphylococcus aureus vaccine (cubic centimeters)—				
Prepared	406	2	404	
Disposed of	456	44	412	
Antigonococcus vaccine (cubic centimeters)—				
Prepared	370	1,146		776
Disposed of	274	42	232	
Normal rabbit serum (cubic centimeters)—				
Prepared				
Disposed of				
Antogenous staphylococcus vaccine (cubic centimeters)—				
Prepared	20		20	
Disposed of	385		385	
Staphylococcus albus vaccine (cubic centimeters)—				
Prepared		85		85
Disposed of		85		85
B. coli vaccine (ampules)—				
Prepared		135		135
Disposed of				
Streptococcus vaccine (ampules)—				
Prepared		82		82
Disposed of		23		23
Antistreptococcus serum (cubic centimeters)—				
Prepared		2,070		2,070
Disposed of		510		510
Vaccine virus (doses)	2,107,359	2,419,723		312,364
Antirinderpest serum (cubic centimeters)		553,666.33		553,666.33
Mallein (doses)	532	280	252	
Other serums (cubic centimeters)		2,833,268		2,833,268
Total	2,107,891	5,806,937.33		3,699,046.33
Miscellaneous:				
Photographs	9,349	14,491		5,142
Natural history specimens	34	84		50
Shop orders	243	269		26
Miscellaneous work	34	36		2
Total	9,660	14,880		5,220

TABLE II.—*Comparative table of routine work performed (free and cash) and supplies manufactured and sold during the fiscal year 1913, as compared with the fiscal year 1912, by value.*

[July 1, 1913.]

Division of the Bureau.	1912	1913	Decrease.	Increase.
General, inorganic, and physical chemistry:				
Metals and alloys	₱187.50	₱474.60		₱287.10
Rocks, minerals, natural pigments, and similar substances	624.00	142.50	₱481.50	
Clays, shales, limestones, limes, wall plasters, cements, and slags	916.44	619.50	296.94	
Fertilizers	142.30	108.00	34.30	
Soils and similar substances	1,691.00	254.00	1,437.00	
Coal analyses	346.00	788.00		442.00
Steaming tests	120.00		120.00	
Calorimetric tests of fuels	160.00	620.00		460.00
Waters	4,800.00	5,425.00		625.00
Crude chemical and miscellaneous analyses	344.80	426.65		81.85
Standard solutions	150.50	70.00	80.50	
Physical tests of wire, twine, fibers, textiles, paper, and similar articles	14.00	190.00		176.00
Cements	6,738.80	9,129.05		2,390.25
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	436.50	271.00	165.50	
Standardization of road materials	132.50	515.00		382.50
Standardization of units of measure—				
Lengths		67.20		67.20
Capacities	194.80	19.00	175.90	
Weights	71.58	69.50	2.08	
Miscellaneous	114.22	174.87		60.65
Total	17,184.94	19,363.87		2,178.93
Organic chemistry:				
Urine, clinical and toxicological analyses	[a]18,632.00	1,992.00	16,640.00	
Essential oils and essences	48.50	288.00		239.50
Petroleum and products, copra, and similar materials	278.00	485.00		207.00
Paints, varnishes, and linseed oils	453.88	370.50	83.38	
Gums, resins, and similar materials	7.00	20.00		13.00
Paper and similar materials	1,260.00	1,223.00	37.00	
Gastric juice, clinical examinations	525.00	325.00	200.00	
Foods, alcohols, and beverages	11,322.50	12,519.50		1,197.00
Food preservatives and coloring matters	440.00	129.00	311.00	
Medicines and similar articles	526.00	1,364.00		538.00
Miscellaneous	812.50	548.00	264.50	
Total	34,305.38	19,264.00	15,041.38	
Mines: Assays	895.75	794.67	101.08	

[a] Includes all urines examined by the biological laboratory.

TABLE II.—*Comparative table of routine work, etc.*—Continued.

Division of the Bureau.	1912	1913	Decrease.	Increase.
Biological laboratory:				
Fæces	₱138,667.00	₱274,334.00		₱135,667.00
Sputum	11,553.00	17,288.00		5,735.00
Blood	17,545.00	80,786.00		63,241.00
Urine	(a)	26,991.00		26,991.00
Gonococci	47,913.00	54,330.00		6,417.00
Waters	28,910.00	42,565.00		13,655.00
Necropsies	1,350.00	2,519.00		1,169.00
Miscellaneous	11,748.00	172,477.00		160,729.00
Total	257,686.00	671,290.36		413,604.00
Serum section of the biological laboratory:				
Vaccine virus	21,800.22	28,875.55		7,075.33
Antirinderpest serum	1,190.78	757.15	₱433.63	
Mallein	591.50	245.70	345.80	
Miscellaneous sera and preparations	3,502.45	5,247.97		1,745.52
Total	27,084.95	35,126.37		8,041.42
Miscellaneous:				
Photographs	5,525.02	8,007.18		2,482.16
Natural history specimens	91.50	127.60		36.10
Shop orders	1,588.11	2,800.27		1,212.16
Miscellaneous work	1,607.74	622.56	985.18	
Supplies	3,018.17			
Sale of documents	7,452.06	6,364.71	1,087.35	
Refunded, work not done, etc. (deducted)	(109.22)	(137.00)		
Power, gas, etc	28,766.35	34,265.70		5,499.45
Reimbursement of traveling expenses etc.	4,131.50			
Total	52,071.23	52,051.02	20.21	
Grand total	389,228.25	797,890.29		408,662.04

[a] Included under organic chemistry.

TABLE III.—*Comparative table of cash receipts for the fiscal year 1913, as compared with the fiscal year 1912.*

[July 1, 1913.]

Division of the Bureau.	1912	1913	Decrease.	Increase.
General, inorganic, and physical chemistry:				
Metals and alloys	₱72.00	₱273.10		₱201.10
Rocks, minerals, natural pigments, and similar substances	79.00	20.00	₱59.00	
Clays, shales, limestones, limes, wall plasters, cements, and slags	738.44	265.50	472.94	
Fertilizers	108.30	108.00	0.30	
Soils and similar substances	731.00	35.00	696.00	
Coal analyses	138.00	173.00		35.00
Calorimetric tests of fuels	80.00	140.00		60.00
Waters	410.00	640.00		230.00
Crude chemical and miscellaneous analyses	236.80	306.40		69.60
Standard solutions	7.50	10.00		2.50
Physical tests of wire, twine, fibers, textiles, paper, and similar articles		157.00		157.00
Cements	6,738.80	9,129.05		2,390.25
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	368.50	268.00	100.50	
Standardization of road materials	110.50	415.50		305.00
Standardization of units of measures—				
Lengths		67.20		67.20
Capacities	13.00	4.00	9.00	
Weights	65.18	3.50	61.68	
Miscellaneous	103.22	10.80	92.42	
Total	10,000.24	12,026.05		2,025.81
Organic chemistry:				
Urines, clinical and toxicological analyses	1,381.00	1,513.00		132.00
Essential oils and essences	32.50	273.00		240.50
Petroleum and products, copra, and similar materials	78.00	177.50		99.50
Paints, varnishes, and linseed oils	229.75	327.50		97.75
Gums, resins, and similar materials	7.00	10.00		3.00
Gastric juice, clinical examinations	375.00	75.00	300.00	
Foods, alcohols, and beverages	1,838.00	914.50	923.50	
Food preservatives and coloring matters	5.00	14.00		9.00
Medicines and similar articles	73.00	93.00		20.00
Miscellaneous	409.50	96.00	313.50	
Total	4,428.75	3,493.50	935.25	
Mines: Assays	832.00	598.67	233.33	
Biological laboratory:				
Fæces	1,172.00	1,147.00	25.00	
Sputum	153.00	111.00	42.00	
Blood	2,184.00	2,816.00		632.00
Gonococci	6.00	18.00		12.00
Waters	480.00	750.00		270.00
Necropsies				
Miscellaneous	42.00	85.00		43.00
Total	4,037.00	4,927.00		890.00

TABLE III.—*Comparative table of cash receipts, etc.*—Continued.

Division of the Bureau.	1912	1913	Decrease.	Increase.
Serum section of the biological laboratory:				
Vaccine virus	₱21,800.22	₱28,876.55		₱7,076.33
Antirinderpest serum	1,190.78	757.15	₱433.63	
Mallein	591.50	245.70	345.80	
Miscellaneous sera and preparations	3,502.45	5,267.97		1,765.52
Total	27,084.95	35,147.37		8,062.42
Miscellaneous:				
Photographs	4,873.82	7,100.26		2,226.44
Natural history specimens	91.50	127.60		36.10
Shop work	419.95	207.20	212.75	
Miscellaneous work	1,607.74	622.56	985.18	
Supplies	3,018.17			
Sale of documents	7,452.06	6,364.71	1,087.35	
Refunded, work not done, etc. (deducted)	(109.22)	(137.00)		
Power, gas, etc	28,766.35	34,265.70		5,499.45
Reimbursement of traveling expenses etc	4,131.50			
Total	50,361.09	48,688.03	1,673.06	
Grand total	96,744.03	104,880.62		8,136.59

TABLE IV.—*Showing free and cash work performed and supplies manufactured and sold to the various departments of the Government and others for the fiscal year 1918.*

[July 1, 1918.]

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
Bureau of Health:				
Urines, clinical and toxicological analyses	7,563	₱21,367.00	₱1,383.00	₱22,750.00
Petroleum and products, copra and similar materials	1	5.00		5.00
Paints, varnishes, and linseed oils	1	25.00		25.00
Gastric juice and clinical examinations	12	250.00	75.00	325.00
Foods, alcohols, and beverages	679	9,329.00		9,329.00
Food preservatives and coloring matters	15	100.00		100.00
Medicines and similar articles	31	330.00		330.00
Waters—				
Chemical	54	860.00		860.00
Biological	860	34,435.00		34,435.00
Fæces	10,456	78,839.00	925.00	79,764.00
Sputum	598	1,682.00	69.00	1,751.00
Blood	11,255	35,273.00	1,558.00	36,831.00
Gonococci	20,519	54,312.00	9.00	54,321.00
Necropsies	74	2,150.00		2,150.00
Miscellaneous biological work and examinations	57,170	170,785.00		170,785.00
Vaccine virus	2,405,115		28,042.41	28,042.41
Miscellaneous sera and preparations	1,644,205		3,166.36	3,166.36
Photographic work	1,387		1,538.43	1,538.43
Shop work	67		142.40	142.40
Total	4,160,112	409,742.00	36,908.60	446,650.60
Bureau of Public Works:				
Metals and alloys	1	4.00		4.00
Crude chemical and miscellaneous analyses	7		104.00	104.00
Cements	3,889		4,250.20	4,250.20
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	15		50.00	50.00
Standardization of road materials	20		200.50	200.50
Miscellaneous chemical analyses and examinations	1	2.50		2.50
Paints, varnishes, and linseed oils	1		9.00	9.00
Waters—				
Chemical	95	3,595.00		3,595.00
Biological	70	3,240.00		3,240.00
Photographic work	219		188.80	188.80
Total	4,318	6,841.50	4,802.50	11,644.00
Bureau of Supply:				
Metals and alloys	5	43.00		43.00
Rocks, minerals, natural pigments, and similar substances	1	10.00		10.00
Coal analyses	39	585.00		585.00
Calorimetric tests of fuels	23	460.00		460.00
Crude chemical and miscellaneous analyses	7	30.00	108.00	138.00

TABLE IV.—*Showing free and cash work performed, etc.*—Continued.

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
Bureau of Supply—Continued.				
Physical tests of wire, twine, fibers, textiles, paper, and similar articles	27	----------	₱106.00	₱106.00
Cements	5,379	----------	3,564.00	3,564.00
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	13	----------	52.00	52.00
Standardization of units of measure—				
Capacities	150	₱15.00	----------	15.00
Weights	660	66.00	----------	66.00
Lengths	96	----------	67.20	67.20
Miscellaneous	202	2.50	----------	2.50
Essential oils and essences	1	15.00	----------	15.00
Petroleum and products, copra, and similar substances	20	140.00	----------	140.00
Paints, varnishes, and linseed oils	27	15.00	178.50	193.50
Foods, alcohols, and beverages	13	96.00	----------	96.00
Paper and similar materials	1	3.00	----------	3.00
Medicines and similar articles	8	75.00	----------	75.00
Miscellaneous biological work	2	20.00	----------	20.00
Waters—				
Chemical	15	225.00	----------	225.00
Biological	20	750.00	----------	750.00
Miscellaneous sera and preparations	20,000	----------	20.00	20.00
Total	26,709	2,550.50	4,095.70	6,646.20
Bureau of Science:				
Metals and alloys	5	88.50	----------	88.50
Rocks, minerals, natural pigments, and similar substances	12	129.50	----------	129.50
Clays, shales, limestones, limes, wall plasters, cements, and slags	21	354.00	----------	354.00
Crude chemical and miscellaneous analyses	4	15.25	----------	15.25
Standard solutions	7	35.00	----------	35.00
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	3	3.00	----------	3.00
Physical test of wire, twine, fibers, textiles, paper, and similar articles	1	4.00	----------	4.00
Standardization of road materials	16	99.50	----------	99.50
Petroleum and products, copra, and similar materials	10	187.50	----------	187.50
Paints, varnishes, and linseed oils	3	26.00	----------	26.00
Foods, alcohols, and beverages	127	1,270.00	----------	1,270.00
Urine, clinical and toxicological analyses	1	3.00		3.00
Miscellaneous	19	35.00	----------	35.00
Waters—				
Chemical	6	105.00	----------	105.00
Biological	61	2,440.00	----------	2,440.00
Blood	1	10.00	----------	10.00
Photographic work	681	1,056.10	----------	1,056.10
Assays	26	8.00	----------	8.00
Shop orders	156	2,582.32	----------	2,582.32
Total	1,160	8,451.67	----------	8,451.67

TABLE IV.—*Showing free and cash work performed, etc.*—Continued.

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
Bureau of Internal Revenue:				
Foods, alcohols, and beverages	15	₱375.00		₱375.00
Medicines and similar articles	135	665.00		665.00
Miscellaneous	2	20.00		20.00
Total	152	1,060.00		1,060.00
City of Manila:				
Crude chemical and miscellaneous analyses	2		₱45.40	45.40
Cements	15		50.00	50.00
Standardization of road materials	3		25.00	25.00
Medicines and similar articles	6		30.00	30.00
Miscellaneous biological work and examinations	1		25.00	25.00
Blood	2		225.00	225.00
Miscellaneous sera and preparations	141,000		141.00	141.00
Total	141,029		₱541.40	₱541.40
Provinces and municipalities:				
Cements	113		301.45	301.45
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	15		43.00	43.00
Standardization of road materials	10		114.00	114.00
Rocks, minerals, natural pigments, and similar substances	1		17.00	17.00
Soils and similar substances	1		5.00	5.00
Medicines and similar articles	4		5.00	5.00
Waters—				
Chemical	3		95.00	95.00
Biological	3		120.00	120.00
Vaccine virus	3,800		114.00	114.00
Miscellaneous sera and preparations	33,000		84.60	84.60
Total	36,950		899.05	899.05
Bureau of Printing:				
Paper and similar materials	99	1,200.00		1,200.00
Petroleum and products, copra, and similar materials	21	7.00		7.00
Assays	1	6.00		6.00
Photographic work	13		72.20	72.20
Total	134	1,206.00	72.20	1,278.20
United States Army and Navy:				
Metals and alloys	3		37.00	37.00
Cements	120		823.90	823.90
Standardization of road materials	1		5.00	5.00
Physical tests of wire, twine, fibers, textiles, paper, and similar articles	30		39.00	39.00
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	7		24.00	24.00
Clays, shales, limestones, limes, wall plasters, cements, and slags	2		10.00	10.00

TABLE IV.—*Showing free and cash work performed, etc.*—Continued.

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
United States Army and Navy—Continued.				
Coal analyses	1		₱15.00	₱15.00
Standard solutions	3		10.00	10.00
Waters, chemical analyses	2		30.00	30.00
Petroleum and products, copra, and similar materials	9		133.00	133.00
Essential oils and essences	6		54.00	54.00
Foods, alcohols, and beverages	18	₱170.00	98.00	268.00
Medicines and similar articles	9		8.00	8.00
Miscellaneous analyses	11		82.00	82.00
Miscellaneous sera and preparations	573,608		887.30	887.30
Vaccine virus	14,064		478.90	478.90
Mallein	240		240.00	240.00
Photographic work	5		30.00	30.00
Total	588,139	170.00	300.10	3,175.10
Bureau of Agriculture:				
Antirinderpest serum	553,666.33		757.15	757.15
Mallein	37		3.70	3.70
Photographic work	278		85.60	85.60
Miscellaneous biological work	11	33.00		33.00
Total	553,992.33	33.00	846.45	879.45
Bureau of Justice:				
Medicines and similar articles	5		25.00	25.00
Blood	1		3.00	3.00
Total	6		28.00	28.00
Executive Bureau: Photographic work	1,338		502.90	502.90
Electrolysis Committee: Metals and alloys	5		63.60	63.60
Bureau of Lands:				
Soils and similar substances	5	150.00		150.00
Assays	1	2.00		2.00
Miscellaneous	1	20.00		20.00
Total	7	172.00		172.00
College of Medicine and Surgery, University of the Philippines:				
Urine, clinical and toxicological analyses	2	6.00		6.00
Photographic work	62		19.60	19.60
Shop work	1		0.61	0.61
Total	65	6.00	20.21	26.21
Bureau of Education:				
Physical tests of wire, twine, fibers, textiles, paper, and similar articles	3		12.00	12.00
Standardization of road materials	1		15.00	15.00
Paper and similar materials	6	18.00		18.00
Miscellaneous	6	30.00		30.00
Photographic work	2,108		584.40	584.40
Shop work	1		2.15	2.15
Total	2,125	48.00	613.55	661.55

TABLE IV.—*Showing free and cash work performed, etc.*—Continued.

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
Bureau of Forestry:				
Coal analyses	1	₱15.00		₱15.00
Calorimetric test of fuels	1	20.00		20.00
Photographic work	263		₱52.20	52.20
Total	265	35.00	52.20	87.20
Bureau of Customs:				
Metals and alloys	7	49.00		49.00
Standardization of units of measure—				
Weights	7		3.50	3.50
Miscellaneous	8		0.80	0.80
Petroleum and products, copra, and similar materials	2	20.00		20.00
Paints, varnishes, and linseed oils	6	3.00	16.00	19.00
Gums, resins, and similar materials	1	10.00		10.00
Paper and similar materials	1	2.00		2.00
Foods, alcohols, and beverages	7	31.00		31.00
Medicines and similar articles	42	206.00		206.00
Soils and similar substances	3	9.00		9.00
Photographic work	16		35.50	35.50
Total	100	330.00	55.80	385.80
Bureau of Quarantine Service:				
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	2		14.00	14.00
Urine, clinical and toxicological analyses	3	7.00		7.00
Fæces	5,545	138,581.00		138,581.00
Sputum	2	6.00		6.00
Blood	2	6.00		6.00
Miscellaneous biological work and examinations	683	2,055.00		2,055.00
Vaccine virus	7,600		76.00	76.00
Total	13,837	140,655.00	90.00	140,745.00
University of the Philippines:				
Urine, clinical and toxicological analyses	5	15.00		15.00
Foods, alcohols, and beverages	9	90.00		90.00
Miscellaneous sera and preparations	34		2.00	2.00
Photographic work	651		386.66	386.66
Shop work	1		3.55	3.55
Miscellaneous biological work	4	9.00		9.00
Total	704	114.00	392.21	506.21
Bureau of Navigation:				
Coal analyses	1	15.00		15.00
Cements	1		5.00	5.00
Standardization of road materials	2		14.00	14.00
Petroleum and products, copra, and similar materials	1	7.00		7.00
Food preservatives and coloring matters	1	15.00		15.00
Waters, biological	5	200.00		200.00
Total	11	237.00	19.00	256.00

TABLE IV.—*Showing free and cash work performed, etc.*—Continued.

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
Philippine Constabulary:				
Fæces	5	₱37.00		₱37.00
Sputum	11	24.00		24.00
Blood	3	153.00		153.00
Physical tests of wire, twine, fibers, textiles, paper, and similar articles	2		₱8.00	8.00
Vaccine virus	34		0.34	0.34
Total	55	214.00	8.34	222.34
Bureau of Prisons:				
Urine, clinical and toxicological analyses	2,024	6,072.00		6,072.00
Foods, alcohols, and beverages	1	3.00		3.00
Miscellaneous chemical analyses and examinations	5	5.00		5.00
Waters, biological	34	750.00		750.00
Miscellaneous biological work and examinations	108	241.00		241.00
Fæces	18,452	55,730.00		55,730.00
Sputum	5,155	15,465.00		15,465.00
Blood	14,169	42,528.00		42,528.00
Necropsies	13	350.00		350.00
Total	39,961	121,144.00		121,144.00
Philippine Exposition: Photographic work	242		48.40	48.40
Philippine Library: Photographic work	60		13.80	13.80
The Sales Agency: Photographic work	12		2.40	2.40
Consulting Architect: Photographic work	24		17.70	17.70
Weather Bureau: Photographic work	62		12.40	12.40
Miscellaneous:				
Metals and alloys	19		172.50	172.50
Rocks, minerals, natural pigments, and similar substances	1		3.00	3.00
Clays, shales, limestones, limes, wall plasters, cements, and slags	31		255.50	255.50
Fertilizers	11		108.00	108.00
Soils and similar substances	2		30.00	30.00
Coal analyses	16		158.00	158.00
Calorimetric tests of fuels	7		140.00	140.00
Crude chemical and miscellaneous analyses	5		49.00	49.00
Cements	38		134.50	134.50
Compression, tensile, or transverse strength of concrete, stone, mortar, rope, iron and steel, etc	6		85.00	85.00
Standardization of road materials	7		42.00	42.00
Standardization of units of measure—				
Capacities	4		4.00	4.00
Miscellaneous	5		10.00	10.00
Urine, clinical and toxicological analyses	47		130.00	130.00
Essential oils and essences	30		219.00	219.00
Petroleum and products, copra, and similar materials	7		44.50	44.50
Paints, varnishes, and linseed oils	9		124.00	124.00

TABLE IV.—*Showing free and cash work performed, etc.*—Continued.

Bureau or Department.	Samples or units.	Free.	Cash.	Total.
Miscellaneous—Continued.				
Foods, alcohols, and beverages	166		₱816.50	₱816.50
Food preservatives and coloring matters	3		14.00	14.00
Medicines and similar articles	3		25.00	25.00
Gums, resins, and similar materials	2		10.00	10.00
Miscellaneous chemical analyses and examinations	14		96.00	96.00
Assays	279		598.67	598.67
Waters—				
Chemical	19		515.00	515.00
Biological	17		630.00	630.00
Fæces	72		222.00	222.00
Sputum	14		42.00	42.00
Blood	108		1,030.00	1,030.00
Gonococci	3		9.00	9.00
Miscellaneous biological work and examinations	8		60.00	60.00
Vaccine virus	3,174		163.90	163.90
Mallein	2		2.00	2.00
Miscellaneous sera and preparations	406,638		986.71	986.71
Photographic work	7,077		3,360.09	3,360.09
Natural history specimens	84		127.60	127.60
Shop work	24		58.49	58.49
Miscellaneous work	34		152.14	152.14
Sales of publications			6,364.71	6,364.71
Power, gas, etc			34,265.70	34,265.70
Reimbursement of traveling expenses etc			393.60	393.60
Refunded, work not done, etc			137.00	137.00
Total	418,604		51,769.11	51,769.11
Grand total	5,990,178.33	₱693,909.67	104,880.62	797,890.29

TABLE V.—*Comparative statement showing expenditures (including obligations incurred) for the fiscal year 1913 as compared with the fiscal year 1912.*

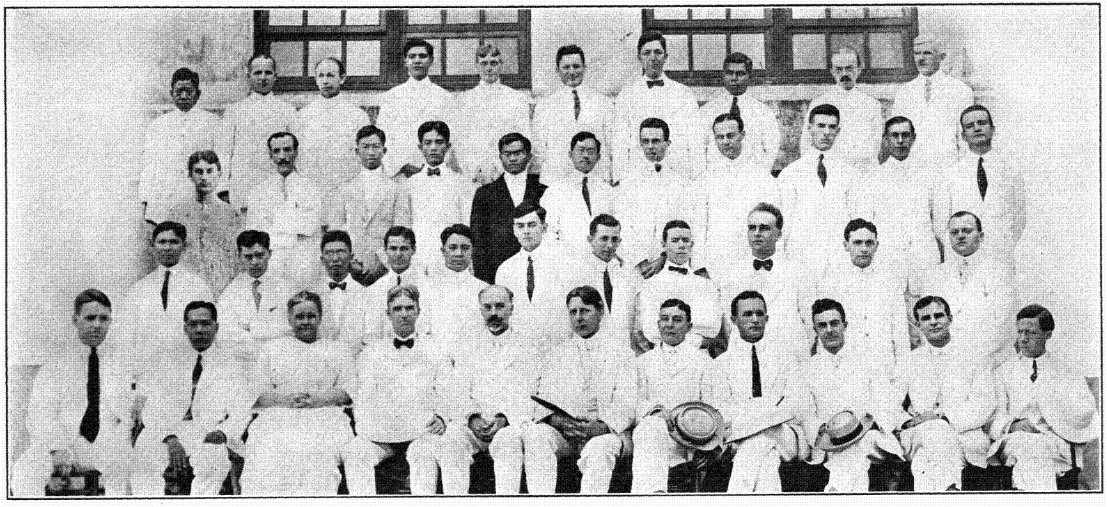
Item.	Expended during the year.	Outstanding obligations on July 1, incurred during the fiscal year.	Total for the fiscal year 1913.	Total for the fiscal year 1912.	Decrease.	Increase.
Apparatus, supplies, etc.:						
Miscellaneous supplies and chemicals	₱17,189.27	₱6,419.52	₱23,608.79	₱30,331.31	₱6,722.52	
Apparatus	4,430.87	12,047.84	16,478.71	18,486.77	2,008.06	
Supplies for power plant, oil, coal, etc	27,722.84	13,343.01	41,065.85	27,913.31		₱13,152.54
Small animals, feed, etc	2,012.39		2,012.39	3,620.28	1,607.89	
Large animals, feed, etc	4,231.49		4,231.49	3,754.15		477.34
Office supplies	3,832.58	86.93	3,919.51	2,545.02		1,374.49
Photographic supplies	3,672.46	162.43	3,834.89	2,471.28		1,363.61
Books, subscriptions, etc	8,216.35	4,560.73	12,777.08	10,524.94		2,252.14
Total	71,308.25	36,620.46	107,928.71	99,647.06		8,281.65
Transportation and freight, etc.:						
Transportation, travel expenses, per diems, launch hire, etc	13,421.20		13,421.20	16,303.82	2,882.62	
City transportation	2,175.15		2,175.15	3,236.86	1,061.71	
Freight	1,134.66		1,134.66	885.14		249.52
Total	16,731.01		16,731.01	20,425.82	3,694.81	
Miscellaneous:						
Telephones and fire alarm boxes	1,518.09		1,518.09	977.54		540.55
Postage, telegrams, and cablegrams	3,181.79		3,181.79	2,541.64		640.15
Repairs to apparatus, furniture, etc	828.94		828.94	1,183.07	354.13	
Laundry	423.21		423.21	410.00		13.21
Printing and binding	26,024.49	11,224.90	37,249.39	35,000.61		2,248.78
Advertising	931.04		931.04	961.94	30.90	
Incidentals, building maintenance, etc	2,075.25		2,075.25	14,234.90	12,159.65	
Museum specimens	4,207.94	100.00	4,307.94	440.10		3,867.84
Total	39,190.75	11,324.90	50,515.65	55,749.80	5,234.15	

TABLE V.—*Comparative statement showing expenditures, etc.*—Continued.

Item.	Expended during the year.	Outstanding obligations on July 1, incurred during the fiscal year.	Total for the fiscal year 1913.	Total for the fiscal year 1912.	Decrease.	Increase.
Salaries and wages:						
Salaries and wages	₱234,083.11		₱234,083.11	₱250,099.14	₱16,016.03	
Transportation and expenses en route foreign country to Manila	3,508.35		3,508.35	3,141.21		₱367.14
Accrued leave and half salary	20,536.28		20,536.28	19,520.12		1,016.16
Total	258,127.74		258,127.74	272,760.47	14,632.73	
Grand total	385,357.75	₱47,945.36	433,303.11	448,583.15	15,280.04	
The outstanding obligations and accounts payable of previous fiscal year unpaid on July 1, 1912, amounted to ₱79,001.23. During the fiscal year 1913, ₱69,776.87 was paid against this amount and the difference between estimates and actual costs and cancellations amounted to ₱5,102.48, leaving the obligations still due on previous fiscal years, ₱14,326.84	69,776.87	14,326.84				
	455,134.62	62,272.20				
Public works: Alterations to boilers, section 4, Act 1989:						
Available, Feb. 12, 1913	8,500.00					
Expended						
Balance	8,500.00					
Aquarium, section 4, Acts 1902 and 1989:						
Available, July 1, 1912	18,899.91					
Expended	16,690.28					
Balance	2,209.63					
Library equipment, Act. 1988:						
Available, July 1, 1912	2,206.39					
Expended	528.31					
Balance	1,624.08					

Appropriation account:		
Allotment, fiscal year 1913		₱340,000.00
Accounts payable, fiscal year 1912		23,499.60
Brought forward from previous fiscal year to cover contingent obligations		43,684.70
Receipts from operation		104,880.62
Restoration, section 4, Act 1989		2,700.00
Total		514,764.92
Expended, as shown above	₱455,134.62	
Outstanding obligations	62,272.20	
Credit	(2,641.90)	
		514,764.92
Balance		
Library fund, Act 1416:		
Available, July 1, 1912		4.44
Expended		4.44
Balance		

INDEX



SCIENTIFIC STAFF OF THE BUREAU OF SCIENCE.

Reading from left to right—*Lower row:* A. E. Southard, J. Guerrero, Mary Polk, M. L. Miller, E. L. Walker, Alvin J. Cox, H. D. Gibbs, E. D. Merrill, W. D. Smith, R. R. Williams, B. C. Crowell. *Second row:* D. Jordan, E. Natividad, T. Dar Juan, F. Peña, P. Moscaira, George W. Heise, H. C. Brill, W. B. O'Brien, A. W. King, H. L. Begley, J. D. Jungmann. *Third row:* E. H. Ruediger, J. Augustino, A. S. Argüelles, F. Valencia, A. Tamayo, V. Q. Gana, W. H. Brown, C. J. Stancliff, A. H. Wells, H. Otley Beyer, Wallace E. Pratt. *Upper row:* A. Celestino, Chas. Martin, R. C. McGregor, F. R. Ycasiano, E. B. Christie, Alvin Seale, L. W. Thurlow, F. Arcaoili, John A. Johnston, M. A. Barber.